Volume 22, Number 9, May 15, 1968

NUCLEAR SCIENCE ABSTRACTS

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Index References

All index entries refer the reader to volume and abstract number:

FOURRIER, Alain
Radioactive chain of mass number 189, 21:10023

Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

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Simple relativistic calculation of the electromagnetic form factors of the deuteron, 21:9744

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evaluation of fallout, for fire and air blast damage, 21:8560 (URS-658-3)
fire resistance of components of, evaluation of, 21:8789(R) (AD-642241)

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

UNION CARBIDE CORP., OAK RIDGE, TENN. Y-12 PLANT.
Mixing and sampling enriched ^{235}U fluids in cylindrical storage containers, 21:8500 (Y-1561)

Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

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3311(Suppl. 2)	21-8567	Dep. mn. CFSTI $3.00 cy, $0.65 mn
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22298	21-9914	Nucl. News, 10: No. 1, 17-20(Jan. 1967)
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23287	21-8498	Dep. mn. CFSTI $3.00 cy, $0.65 mn
23420	21-8764	Lancet, 2: 672-5(Sept. 24, 1966)
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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 16480, 16523, 16552, 16636, 16638, 16639, 16656, 16668, 16682, 16883, and 17416.

16381 (AECL-2799) THE DETERMINATION OF CHLORINE AND FLUORINE IN ZIRCONIUM OXIDE AND ZIRCONIUM: SOME EXPERIENCE WITH A PYROHYDROLYSIS PROCEDURE. Stewart, R. B.; Elchuk, S.; Grant, M. A. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Nov. 1967. 19p. Dep. CFSTI. CAN.

A procedure for the determination of chlorine and fluorine in refractory solids and metals is described and evaluated. It uses a pyrohydrolytic separation at 1000 to 1100°C. The measurement of chloride is by potentiometry or colorimetry, that of fluoride by spectrophotometry. Sensitivities of 1 μg/g are attainable. Data derived from known additions are given and discussed. (auth)

16382 (AERE-Bib-158) LIST OF UNCLASSIFIED DOCUMENTS, LECTURES, ETC. BY THE STAFF OF THE ANALYTICAL SCIENCES DIVISION, A.E.R.E., HARWELL 1967. Leatham, J. M. (comp.) (Atomic Energy Research Establishment, Harwell (England)). Jan. 1968. 12p. Dep. CFSTI. UK 2s. 6d.

This list constitutes unclassified material published or presented during 1967 by the staff of the Analytical Sciences Division AERE, Harwell. It covers reports, memoranda, conference papers, books, lectures, and articles that appeared in journals. It includes a few items published in 1966 that did not appear in the previous bibliography (AERE-Bib 152). (auth) (UK)

16383 (AERE-R-5606) CHROMATOGRAPHIC DETERMINATION OF HYDROGEN ISOTOPES IN ZIRCONIUM ALLOYS BY CARRIER GAS EXTRACTION. Perkins, R.; Moreton-Smith, M. J. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1967. 7p. Dep. CFSTI. UK 1s 9d.

A gas chromatographic method for determination of hydrogen isotopes in zirconium alloys is described. The apparatus utilizes carrier gas extraction, and is capable of determining the hydrogen and deuterium content of 700 μl samples of mixed hydrogen isotopes containing 10 μl of the minor component to an accuracy of ±3%. (auth) (UK)

16384 (AERE-R-5637) THE DETERMINATION OF PLUTONIUM ALPHA ACTIVITY IN URINE BY SURFACE ADSORPTION AND ION EXCHANGE. Eakins, J. D. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1967. 12p. Dep. CFSTI. UK 2s. 6d.

Work was carried out to select and evaluate an ion-exchange procedure which, in conjunction with the surface adsorption method for determining gross alpha activity in urine, gives a highly specific procedure for plutonium alpha activity. The chosen procedure was examined with reference to decontamination from other actinide elements, recovery of plutonium, and the source of background activity. The decontamination factors for other actinide elements were in excess of 100 in all cases. The overall recovery of plutonium was 89 ± 4%, and the background activity obtained from the urine of unexposed people was 0.015 ± 0.005 pCi/1500 ml. The procedure is suitable for analysing large numbers of samples and requires little operator expertise. The use of the same basic procedure for gross alpha activity and plutonium has advantages both in economy of materials and ease of staff training. (auth) (UK)

16385 (CEA-R-3219) ANALYSE CHIMIQUE ET ISOTOPIQUE DU BORE DANS L'URANIUM PAR SPECTROMETRIE DE MASSE. (Chemical and Isotopic Analysis of Boron in Uranium by Mass Spectrometry). Chenouard, Jean; Nief, Guy (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 14p. (In French). Dep.

A method is described for the determination by mass spectrometry of the concentration and the isotopic composition of small quantities of boron in uranium. The concentration range is between 10 and 100 ppM. The boron is extracted by distillation of methyl borate. The concentration is determined by isotopic dilution. Many precautions have to be taken to limit and correct contaminations. This method of analysis is applicable for at least 0.2 μg of boron; the relative accuracy is about 2%. (auth)

16386 (CEA-R-3222) FIXATION ET SEPARATION DES ELEMENTS THORIUM ET URANIUM PAR LES RESINES ECHANGEUSES D'ANIONS EN MILIEU NITRATE. (Fixation and Separation of Elements Thorium and Uranium by Ion Exchange Resins in Nitrate Solutions). Korgaonkar, Vasant (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 61p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

The exchange of thorium and uranium between a strong base anion resin and a mixed water + ethanol solvent containing nitrate ions was studied. It was assumed that in the resin the thorium and uranium are fixed in the form of the complexes $Th(NO_3)_6^{2-}$ and $UO_2(NO_3)_4^{2-}$; in solution these elements are present in the form of complexes having the general formulas: $Th(NO_3)_{6-n}^{n-2}$ and $UO_2(NO_3)_{4-n}^{n-2}$. It was possible to deduce a law for the changes in the partition functions of thorium and uranium as a function of the concentrations of the various species in solution and of the complexing ion NO_3. From this was deduced the optimum operational conditions for separating a mixture of these two elements. Under these conditions, the influence of the following interfering ions was studied: Ba, Bi, Ce, La, Mo, Pb, and Zr. The method proposed can be used either as a preparation, or for the determination of thorium by a quantitative separation. (auth)

16387 (CEA-R-3267) APPLICATION DE L'ANALYSE PAR ACTIVATION NEUTRONIQUE A L'ETUDE DES IMPURETES DANS LE MOLYBDENE, LE TUNGSTENE ET LE GRAPHITE NUCLEAIRE. (Application of Neutron Activation Analysis to the Study of Impurities in Molybdenum, Tungsten, and Nuclear Graphite). Pinte, Guy (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 76p. (In French). Dep.

A neutron activation method is described for analysis of a maximum number of foreign elements in molybdenum, tungsten, and graphite. The various elements are isolated using a systematic separation program; the elements are subsequently determined qualitatively and quantitatively using γ spectrometry. By this method 27 elements in molybdenum and tungsten, and 20 elements in graphite are determined, to which can be added those elements that are already the object of routine analysis: V, Mn, Si, P, S, Cl, and 14 rare earths. (auth)

16388 (CEA-R-3307) ANALYSE PAR ACTIVATION AUX PHOTONS γ. (Activation Analysis Using γ Photons). Engelmann, Charles (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 64p. (In French). Dep.

All the data required for using photonuclear reactions in the field of analysis are summarized. After a brief review of the elementary properties of nuclear reactions induced by photon irradiation, the main characteristics are given of high-energy (E > 20 MeV) bremsstrahlung sources. The principle of activation analysis based on the use of photons is given. Actual examples of the analytic possibilities are described in detail, in particular in the case of the determination of very small quantities ($<10^{-6}$) of C, N, O, and F. The influence of interfering nuclear reactions is discussed. (auth)

16389 (CEA-R-3391) DOSAGE DU ^{137}Cs DANS LES EFFLUENTS RADIOACTIFS PAR LE TETRAPHENYLBORATE DE SODIUM. (Determination of ^{137}Cs in Radioactive Wastes by the Application of Sodium Tetraphenylborate). Testemale, Gilbert; Girault, Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec. 1967. 33p. (In French). Dep.

A simple technique for determination of ^{137}Cs was developed. The technique consists in the formation of cesium tetraphenylborate, followed by a double extraction with isoamyl acetate, and washing of the organic phase. The counting of known parts of the cesium solution and assaying of its purity by γ spectrometry enable the determination of ^{137}Cs. The yield is about 98 per cent. (auth)

16390 (COO-1540-8) GEOCHEMICAL STUDY OF SOME MANGANESE NODULES. Bacon, Joan Irene (Tulsa Univ., Okla. Dept. of Chemistry). 1967. Contract AT(11-1)-1540. 53p. Dep. CFSTI.

Thesis.

Atomic absorption spectroscopy was utilized in the elemental analysis of 16 manganese nodules. Concentrations were determined for B, Na, Mg, Al, Si, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Sr, Mo, Ag, Ba, Tl, and Pb. Of these, B, Sc, Ga, Ag, Ba, and Tl either were absent from the nodules analyzed or were present in concentrations below limits of detection. Possible linear relationships were noted for Mn–Ni, Mn–Pb, Mn–Mo, Mn–Cr, Cu–Ni, Fe–Si, Fe–Ca, Zn–Ni, Zn–Cu, Ti–Mo, and Ti–Pb. Of the linear trends noted, Mn–Pb, Mn–Mo, and Mn–Cr have not been reported previously. ^{230}Th/^{231}Pa and ^{234}U/^{238}U, radiochemical dating techniques, were used to determine rates of accretion for selected nodules. The ^{234}U/^{238}U method indicated a rate of formation of approximately 2.5 mm/10^6 year. This value is in good agreement with data obtained by others using other methods of measurement. Anomalously high rates by the ^{230}Th/^{231}Pa method were presumably due to sampling difficulties. (auth)

16391 (GA-8171) PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON FORENSIC ACTIVATION ANALYSIS HELD SEPTEMBER 19–21, 1966 AT GENERAL ATOMIC LABORATORIES IN SAN DIEGO, CALIFORNIA. Guinn, V. P. (ed.) (Gulf General Atomic, Inc., San Diego, Calif.). 314p. (CONF-660937). Gulf General Atomic, Inc., San Diego, Calif. $7.00.

Twenty papers and one abstract are included; separate abstracts were prepared for 19. The remaining paper was previously abstracted for NSA and appeared as abstract 21: 4436. (D.H.M.)

For abstracts of individual papers see: 16392–16410.

16392 (GA-8171, pp 7-40) NEUTRON ACTIVATION ANALYSIS AND ITS FORENSIC APPLICATIONS. Guinn, Vincent P. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

A description of the neutron activation method of analysis and some of its application to problems of concern in the field of criminalistics are presented. Some topics discussed are the nuclear reactor; sensitivity of the method; forms of the method, including the purely instrumental and the radiochemical-separation forms and in general, forensic applications. Limits of detection for 75 elements by neutron activation analysis at a thermal neutron flux of 10^{13} n/cm^2-sec are tabulated. (D.H.M.)

16393 (GA-8171, pp 41-8) SOME CRIMINALISTICS PROBLEMS, AND NEUTRON ACTIVATION ANALYSIS. Kirk, Paul L. (California Univ., Berkeley. School of Criminology).

The problems arising from combining nuclear science and criminalistics are discussed, including the basic problem of sampling and sample integrity. Specific problems involved in the analysis of soil, hair, and blood are considered. (D.H.M.)

16394 (GA-8171, pp 49-62) ORGANIZATION AND EQUIPMENT OF AN ACTIVATION ANALYSIS LABORATORY. Lenihan, J. M. A. (National Health Service, Glasgow (Scotland). Western Regional Hospital Board).

Problems of organization and equipment likely to be encountered in a forensic laboratory seeking to practice the technique of activation analysis are discussed. It was concluded that the selection of the type of activation analysis correct for an individual forensic laboratory must be based on its ambitions and responsibilities as well as economics. (D.H.M.)

16395 (GA-8171, pp 63-78) EARLY FORENSIC NEUTRON ACTIVATION ANALYSIS STUDIES AT THE OAK RIDGE NATIONAL LABORATORY. Leddicotte, George W. (Missouri Univ., Columbia).

Results of a feasibility study are reported that was started early in 1959 at Oak Ridge National Laboratory on the use of activation analysis in law enforcement work in which the objectives were to show that samples of physical evidence could be compared or differentiated from each other by a qualitative neutron activation method; to show that differences in the concentration of individual chemical element components could be quantitated to assist in the comparison of samples; and to establish a relationship of these preliminary tests to the subsequent analysis of large groups of samples. In the experiments portions of each test sample were irradiated and the neutron-induced γ-radioactivity of each specimen was measured by means of a γ-scintillation spectrometer. The photopeaks of each γ-spectrum became "fingerprints" or "patterns" of the elements that made up the samples' composition. Some data on the analysis of soot, soil, black paints, drugs, and raw opium are reported. (D.H.M.)

16396 (GA-8171, pp 79-102) APPLICATION OF SPECIAL COUNTING TECHNIQUES TO FORENSIC PROBLEMS. Wahlgren, Morris A. (Argonne National Lab., Ill.).

Several instrumental techniques are described which permit better selectivity to be attained in certain comparisons of physical evidence samples by nondestructive activation analysis. Experimental sensitivities are reported for the detection of x-rays of rare earth radioisotopes in "coded" samples, using lithium-drifted silicon and germanium diodes. For low count-rate samples a beta–gamma coincidence system utilizing an automatic sample changer was used to reduce the normal background interference. Similar techniques can be used to reduce interference from other activities in irradiated samples. The use of lithium-drifted germanium detectors for other applications in forensic activation analysis is also discussed. (auth)

16397 (GA-8171, pp 103-16) FORENSIC APPLICATIONS OF NEUTRON ACTIVATION ANALYSIS. Pro, M. J.; Schlesinger, H. L.; Hoffman, C. M. (Internal Revenue Service, Washington, D. C. Alcohol and Tobacco Tax Div. Lab.).

In order to illustrate the potential worth of neutron activation analysis as a tool in criminalistics, the analysis of some of the most frequently examined types of physical evidence ("moonshines," soils, drugs, and gunshot residues) is described. The use of neutron activation analysis to determine the authenticity of stamps and coins is also described. (D.H.M.)

16398 (GA-8171, pp 119-32) REVELATION OF INTERNAL STRUCTURE OF PAINTINGS THROUGH NEUTRON ACTIVATION AUTORADIOGRAPHY. Sayre, Edward V. (Brookhaven National Lab., Upton, N. Y.).

A neutron activation autoradiographic study of oil paintings revealed, safely and nondestructively, many details of materials and methods used by the artist. Results obtained by x-ray radiography and activation autoradiography were compared. Neutron activation autoradiography was used to reproduce images of badly faded early photographic prints. (D.H.M.)

16399 (GA-8171, pp 133-44) COMPARISON OF PAINT SAMPLES BY NEUTRON ACTIVATION ANALYSIS. Bryan, Donald E. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

Neutron activation analysis was used to determine the homogeneity of paint on a painted surface, to distinguish differences in trace element composition of samples of the same paint, but from different batches, and to analyze paints from different manufacturers. Neutron activation analysis requires very small samples and if the instrumental form is employed, it is a nondestructive technique. Another advantage is its great sensitivity for most elements. In order to be of value in the examination of evidence in actual cases, much background information is needed; therefore, a large-scale survey analysis of several hundred paint samples is in progress. (D.H.M.)

16400 (GA-8171, pp 147-60) NEUTRON ACTIVATION AND PHOTONUCLEAR ACTIVATION ANALYSIS OF GLASS SAMPLES. Settle, Dorothy M. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The use of thermal neutron (NAA) and photonuclear (PNAA) activation analysis to determine the elements in glass was investigated. The main problem encountered in the NAA was the large interference produced by 15.0-hour ^{24}Na, due to the large sodium content of most glass. In 27 different types and brands of glass analyzed by thermal neutrons at 1.8×10^{12} n/cm^2-sec, a total of 11 elements were detected: Na, Ba, Zn, As, Co, Fe, Cr, Sc, Hf, Zr, and Sb. Studies are in progress using PNAA, which does not result in very large ^{22}Na activity even for glass containing 10% sodium. (D.H.M.)

16401 (GA–8171, pp 161-76) DETERMINATION OF TRACES OF BARIUM AND ANTIMONY IN GUNSHOT RESIDUES BY ACTIVATION ANALYSIS. Guinn, Vincent P. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

Since all known U. S. ammunition and most European ammunition contains antimony (as Sb_2S_3) in the cartridge primer, and most also contain barium (as $Ba(NO_3)_2$) in the primer, the possibility of detecting these elements on the back of the gunhand was investigated using neutron activation analysis (NAA). Variables in the deposition of gunshot residues, including the brand of ammunition, wind direction and velocity, dryness or moistness of skin, number of firings, distribution of gunshot residues on the gunhand, and the method of removal of gunshot residues, are discussed. With the completion of further studies and further refinements now in process, it is believed that the NAA technique will become the standard technique for the determination of gunshot residues. (D.H.M.)

16402 (GA–8171, pp 177-88) DISTANCE DETERMINATION OF GUNSHOT FIRINGS BY NEUTRON ACTIVATION ANALYSIS. Krishnan, S. S. (Ontario Province Attorney-General's Lab., Toronto).

Results of an investigation to determine the firing distance by using concentration patterns of antimony and copper around bullet holes obtained by neutron activation analysis (NAA) are reported. Due to the ability of NAA to detect extremely small amounts of metallic elements, the range of detection of firearm-discharge residues were extended up to twice the present range. The accuracy of firing-distance determination by the NAA method depended upon the reproducibility of the concentration pattern and the slope of the concentration vs firing-distance curve. (D.H.M.)

16403 (GA–8171, pp 189-98) BULLET RESIDUE TRANSFERENCE TO VARIOUS MATERIALS. Schlesinger, Howard L.; Hoffman, C. M.; Pro, M. J. (Internal Revenue Service, Washington, D. C. Alcohol and Tobacco Tax Div. Lab.).

In an attempt to identify bullet holes made in a variety of materials, neutron activation analysis was used to try to relate residues deposited on targets to such variables as caliber, bullet type and cartridge manufacturer. It was found that when a cartridge is fired, the surface of the bullet is coated with antimony, copper, and barium materials, and when the bullet strikes a target such as leather or cloth, some of this residue and some of the bullet metal are transferred to the materials in quantities that are easily detectable by instrumental neutron activation analysis. (D.H.M.)

16404 (GA–8171, pp 203-20) THE TRACE-ELEMENT CONTENT OF HUMAN HEAD HAIR IN ENGLAND AND WALES AND THE APPLICATION TO FORENSIC SCIENCE. Coleman, Ronald F.; Cripps, F. H.; Stimson, A.; Scott, H. D. (Atomic Weapons Research Establishment, Aldermaston (England)).

A quantitative assessment of the value of trace analysis of hair by neutron activation methods (NAA) in forensic examinations was made. Problems involved in the analysis of hair are discussed and data on trace-element concentration in hair throughout the population and variations of single hairs on the same head are presented. It was concluded that it was possible to use NAA in cases in which a criminal leaves a hair at the scene of the crime and a suspect is picked up within a few days or in cases associating an object or a person on which a hair is found with a victim. (D.H.M.)

16405 (GA–8171, pp 221-36) INDIVIDUALIZATION OF HUMAN HEAD HAIR. Perkons, Ausekelis K. (Centre of Forensic Sciences, Toronto (Ontario)).

Results obtained from a large-scale neutron activation study of over 20 elements in more than 1,200 hair samples are discussed. It was found that the variations of trace element concentration in hair over the head of one person are larger than the experimental error, and the variations between different individuals are at least an order of magnitude larger than those inherent in one person's head hair. It was concluded that hair identification is feasible if enough care is taken in obtaining and interpreting the results. An empirical method of comparison of the components seen in the gamma-ray spectra of hair samples, by peak-height comparison, was developed. (D.H.M.)

16406 (GA–8171, pp 237-46) NEUTRON ACTIVATION ANALYSIS OF SOME HAIR SAMPLES AS EVIDENCE FOR AN AUSTRALIAN COURT. Smythe, Lloyd E.; Ryan, W. P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights).

An example of the use of neutron activation analysis evidence in a murder trial is presented. Results from neutron activation analysis of hair was accepted for the first time by an Australian court. (D.H.M.)

16407 (GA–8171, pp 261-78) EXOGENOUS CONTAMINATION OF HAIR BY CAPILLARY ACTION OF ARSENIC SOLUTIONS. Lima, Fausto W. (Instituto de Energia Atomica, Sao Paulo (Brazil)).

A study of the amount of arsenic in human hair under varying conditions is reported using neutron activation analysis. It was concluded that arsenic may appear in the hair shaft at points distant from the scalp, in cases of administration of small doses (chronic poisoning), by other mechanisms than deposition of arsenic by the blood supply, in the hair root pre-keratin tissues, and subsequent growing of the hair. In cases of chronic poisoning care should be exercised in the determination of the time that arsenic started being administered to the patient. (D.H.M.)

16408 (GA–8171, pp 279-86) ARSENIC IN HAIR. Erickson, Norman E. (Centre of Forensic Sciences, Toronto (Ontario)).

Research and case work done at The Centre of Forensic Science involving neutron activation analysis of biological materials in the investigation of arsenical poisoning are reported. Experiments with guinea pigs involving inducing non-lethal doses of arsenic to one pair and lethal doses to another pair are described. It was found that arsenic is apparent on the surface of the skin tissue soon after arsenic is administered. In the experiments on chronic poisoning, this external contamination from sweat became apparent in sections of hair, other than the root section, only after some length of time, and still more markedly with a second and larger dose. There was a much higher internal deposition of arsenic in sections of growing hair than in corresponding sections of non-growing hairs. In acute poisonings, no significant levels of arsenic were found, other than that of the root sections. (D.H.M.)

16409 (GA–8171, pp 287-94) VALUE OF NEUTRON ACTIVATION ANALYSIS HAIR COMPARISONS IN FORENSIC INVESTIGATIONS: A CRITIQUE. Jervis, Robert E. (Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry).

The state of neutron activation analysis of hair in forensic investigations is reviewed and some recommendations on desirable techniques to be used for this purpose are presented. It was concluded that activation hair comparisons should be ready for use in actual case investigations at the present time, if a sufficient hair specimen is available, a few milligrams or more, and if sufficiently intense and prolonged neutron activation is performed to allow quantitative determination of more than 10 elements in the hair with a precision of better than 10%. (D.H.M.)

16410 (GA–8171, pp 295-314) ACTIVATION ANALYSIS IN FORENSIC SCIENCE USING RADIOCHEMICAL SEPARATIONS. Smith, Hamilton (Glasgow Univ. (Scotland). Dept. of Forensic Medicine).

Work in activation analysis using radiochemistry that can be done in a normal chemical laboratory using only simple detection equipment is described. Sample preparation, irradiation, and processing in the determination of As, Hg, Sb, and Cu in human tissue are discussed. (D.H.M.)

16411 (GAT–507) DETERMINATION OF TRACE ELEMENTS IN URANIUM COMPOUNDS: SPECIFICATION ANALYSES. (Goodyear Atomic Corp., Piketon, Ohio). Jan. 2, 1968. Contract AT(33-2)-1. 151p. Dep. CFSTI.

A method is described for the microanalysis of fourteen elements in uranium and uranium compounds by atomic absorption spectroscopy. These elements include aluminum, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, sodium, and zinc. A sample is dissolved in 6 to 8 $\underline{N}$ nitric acid, from which the uranium is selectively removed by a single extraction with tributyl phosphate. The aqueous layer is evaporated to dryness and the residue is redissolved in 0.2 $\underline{N}$ hydrochloric acid. Any or all of the elements can then be determined in this one solution by atomic absorption spectroscopy. The limits of error in the analyses are less than 10%. Thus, the method gives about the same precision as colorimetric procedures, and it is much more precise than emission spectroscopy. (auth)

16412 (GAT-T–1475) PROCEDURES FOR THE ACCURATE ANALYSIS OF URANIUM IN A VARIETY OF IMPURE MATERIALS. Trivisonno, C. F.; Walker, C. R.; Vita, O. A. (Goodyear Atomic Corp., Piketon, Ohio). Jan. 31, 1968. Contract AT(33-2)-1. 13p. (CONF-671012–6). Dep. CFSTI.

From 11th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

The titration of uranium with dichromate using ferrous ion in strong phosphoric acid as a reductant (i.e., the method of Davies and Gray) was evaluated. This method has the advantage that it can be used directly for many impure uranium samples. Solvent extraction and differential colorimetry were applied to the determination of low concentrations of uranium in very impure solutions. In this procedure, the uranium is separated by a single solvent extraction as its tetrapropylammonium complex with methyl isobutyl ketone and is determined on a measured portion of the extract by differential colorimetry using dibenzoylmethane to develop the color. The use of potassium bifluoride is described as a fusion mix for the dissolution of uranium in refractory metal matrices. This fusion mix proved invaluable for dissolving a wide variety of acid-resistant nuclear fuel residues. Through the application of one or more of these techniques or procedures, a system was developed that can provide a relatively rapid and accurate uranium analysis of nearly any uranium-bearing material. The system compares favorably both in speed and accuracy with other chemical and mass spectrometer methods. The analytical precisions obtainable by the methods presented vary from 0.2 to 1.5% (expressed in limits of error at the 95% confidence interval) depending on the type of sample involved. For the usual type of sample, the limit of error is about 0.5%. (auth)

16413 (IAE-1165) OPREDELENIE SODERZHANIYA KISLORODA V GERMANII I KREMNII PRI AKTIVATSII IONAMI GELIYA-3. (Determination of the Oxygen Content in Germanium and Silicon by Activation by ^{3}He Ions). Aleksandrova, G. I.; Demidov, A. M.; Kotel'nikov, G. A.; Pleshakova, G. P.; Sukhov, G. V.; Choporov, D. Ya.; Shmanenkova, G. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 15p. (In Russian). Dep.

A method is described for determination of oxygen in germanium and silicon, to be used as a basis for selection of spectrometric detectors. Polished Ge and Si specimens were irradiated with ^{3}He ions in a cyclotron. The surface oxide layer was removed by etching. The O_2 content was determined from the positron activity of ^{18}F as measured in a gamma-gamma coincidence spectrometer with an NaI(Tl) crystal. The possibility is shown of analyzing gallium arsenide, tungsten, silicon carbide, and other materials. A sensitivity of 10^{-7}% is claimed for the method. (JPRS)

16414 (LA-3841) VARIABILITY IN THE STANDARDIZATION OF CERIC SULFATE SOLUTION FOR THE TITRATION OF PLUTONIUM. Waterbury, Glenn R.; Croley, Dale C.; Metz, Charles F. (Los Alamos Scientific Lab., N. Mex.). Oct. 15, 1967. Contract W-7405-eng-36. 6p. Dep. CFSTI.

The titer for a ceric sulfate solution was 0.2% lower using sodium oxalate as a standard than when using either arsenic trioxide or plutonium metal standards. Difficulty in standardizing ceric sulfate solutions was experienced infrequently in the past and seemed to be associated with a very few lots of ceric sulfate reagent solution. The differences in titers emphasized the fact that the standard material should be similar to the samples to be analyzed. The potential user of ceric sulfate should be alerted to this possible, though rare, error in standardization. (auth)

16415 (NYO-3369-9) ISOTOPIC ABUNDANCE STUDIES BY NEUTRON ACTIVATION ANALYSIS. Summary Report, April 14, 1964–December 1, 1967. Corless, James T. (Rhode Island Univ., Kingston. Graduate School of Oceanography). Jan. 15, 1968. Contract AT(30-1)-3369. 56p. Dep. CFSTI.

Studies were made to determine if detectable variations exist in the abundances of the stable isotopes of calcium and if a precise and sensitive technique based on neutron activation analysis could be developed for measurement of these variations. A method for determination of ^{44}Ca in natural calcium by neutron activation methods is described. The sensitivity and precision of this method are comparable to present-day solid-source mass spectrometers. A limited series of analyses indicated that natural variations do exist in the abundances of the stable isotopes of calcium. These variations amount to ~1%. (M.C.G.)

16416 (EURFNR-386) SPECTROPHOTOMETRIC DETERMINATION OF PLUTONIUM VALENCIES IN NITRIC ACID SOLUTIONS. Ochsenfeld, W.; Schmieder, H. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). Translation of report KFK-610. 21p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 6255. (P.C.H.)

16417 MODIFICATION OF DITHIOL TESTS FOR THE FIELD DETERMINATION OF MOLYBDENUM. Stubbs, M. F. (Texas Technological College, Lubbock). Analyst, 93: 59-60(Jan. 1968).

Modifications of currently used dithiol tests for field determination of molybdenum were developed. The molybdenum is oxidized and extracted quickly and selectively with sodium hypochlorite at room temperature. The disadvantages of using an alkaline fusion or oxidation with potassium chlorate and hot hydrochloric acid are avoided. (auth) (UK)

16418 A NEW OXIDIMETRIC REAGENT: POTASSIUM DICHROMATE IN A STRONG PHOSPHORIC ACID MEDIUM. VIII. POTENTIOMETRIC TITRATION OF MOLYBDENUM(VI) AND VANADIUM(V). Muralikrishna, U.; Gopala Rao, G. (Andhra Univ., Waltair, India). Talanta, 15: 143-4(Jan. 1968).

A titrimetric method is described for the determination of Mo(VI) involving prior reduction to Mo(V) with an excess of Fe(II) in a concentrated phosphoric acid solution, followed by titration with dichromate. The titration can be done at room temperature and without protective atmosphere. Uranium interferes, but vanadium may be determined simultaneously. (auth) (UK)

16419 REACTIONS OF TECHNETIUM HEXAFLUORIDE WITH NITRIC OXIDE, NITROSYL FLUORIDE, AND NITRYL FLUORIDE. Holloway, John H.; Selig, Henry (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 30: 473-8(Feb. 1968).

Reactions of technetium hexafluoride with nitric oxide, nitrosyl fluoride, and nitryl fluoride gave the compounds $NOTcF_6$, $(NO)_2TcF_8$, and NO_2TcF_7. Magnetic properties and ir spectra of these compounds were studied and compared with some analogous complexes of the hexafluorides of tungsten, rhenium, and osmium. Attempts to prepare $NOTcF_7$ were unsuccessful. (auth) (UK)

16420 DETERMINATION OF RADIORUTHENIUM IN ENVIRONMENTAL OBJECTS. Tikhomirov, V. K.; Petrukhin, N. V. Gig. Sanit., No. 10, 87-92(Oct. 1967). (In Russian).

The widespread peaceful application of nuclear energy makes it necessary to determine in the environment not only definitely harmful isotopes, such as ^{90}Sr and ^{137}Cs, but also the less toxic ^{103}Ru and ^{106}Ru because they are formed at a high yield and have a relatively long half-life. They are accumulated in the soil and thus may contaminate reservoirs located near nuclear power plants. Metallic ruthenium was used as carrier for determination of the radioactive ruthenium isotopes. The analysis involved dissolution of the sample in sodium hypochlorite and precipitating black ruthenium hydroxide, soluble in hydrochloric acid. The samples were obtained by calcining specimens from the contaminated soils, together with plants at temperatures between 400 and 500°C. The ashes and the carrier were melted together with a strong oxidizing agent, such as caustics, potassium carbonate or nitrate, to destroy the silicate structure of the soil. Radioactive and carrier ruthenium were leached with water and sodium hypochlorite and were precipitated by iron, nickel, or aluminum hydroxide or mercury or copper sulfide. Radioactive isotopes were separated by distillation, extraction, or ion exchange and were identified on the basis of their γ peaks in the 0.5-MeV range. ^{106}Ru may also be identified by scintillation β spectrometry, making use of its rhodium daughter product, ^{106}Rh. (TTT)

16421 RADIO-RELEASE IN REVIEW. Carden, Joan E. Isotop. Radiat. Technol., 5: 104-12(Winter 1967-68).

Development of the radio-release method of materials analysis is described. Radio-release is the term used to describe a tracer technique in which a sample is analyzed without the necessity of the radioactive isotope being embodied in the sample from the beginning of the experiment. The kryptonates are excluded, but 11 other successful radio-release techniques are discussed in detail, and sensitivity data are presented. (P.C.H.)

16422 TRACERLAB RADIOISOTOPE FACILITIES. Isotop. Radiat. Technol., 5: 123-5(Winter 1967-68).

The Tracerlab Western Division radiochemical facilities and program are described. Radioisotopes determined by Tracerlab and half-life determinations are tabulated. (P.C.H.)

16423 ULTRATRACE-ELEMENT RESEARCH IN THE LIFE SCIENCES USING ACTIVATION ANALYSIS. Leddicotte, G. W. (Univ. of Missouri, Columbia). Isotop. Radiat. Technol., 5: 200-6(Spring 1968).

The present state of the neutron activation method for using trace elements in problems in life-sciences research is discussed. Applications are described to reflect some areas of immediate interest. These include medicine, agriculture, nutrition research, and environmental science. Data are reported on determination of trace rare earths in bone ash, trace elements in animal tissues, and trace heavy elements in pharmaceuticals. The use of neutron activation analysis to obtain systematic knowledge of the properties of trace elements in soils and vegetation is also discussed. (P.C.H.)

16424 ANALYTICAL CHEMISTRY OF RARE ELEMENTS. Busev, A. I. (Moscow State Univ.). Zh. Anal. Khim., 22: 1781-9 (Dec. 1967). (In Russian).

A description is given of the development of analytical chemistry of rare elements in the Soviet Union during the past 50 years.

16425 DETERMINATION OF MOLYBDENUM(VI) BY A KINETIC METHOD WITH THE USE OF SELENATE IONS. Lazarev, A. I. (Inst. of New Chemical Problems, Moscow). Zh. Anal. Khim., 22: 1836-40(Dec. 1967). (In Russian).

The catalytic action of molybdenum(VI) compounds on the reaction between selenate and tin(II) has been used for the kinetic determination of small amounts of molybdenum. The sensitivity of the method is 0.001 μg/ml of molybdenum if the time of the color development is 30 min. Oxidants, complex forming compounds, rhenium, and some others interfere in the determination. The method has been used for the determination of molybdenum in steels. The variation coefficient of the results is about 7%. A method has also been developed for determining large amounts of molybdenum as $PbMoO_4$ by means of in situ nascendi reagents. (auth)

16426 DIRECT DETERMINATION OF URANIUM(VI) IN TRIBUTYL PHOSPHATE–SINTIN SOLUTIONS BY A LUMINESCENT METHOD. Dobrolyubskaya, T. S.; Anikina, L. I. Zh. Anal. Khim., 22: 1841-4(Dec. 1967). (In Russian).

A study has been made of the uranium(VI) luminescence in tributyl phosphate—sintin (hydrogenated kerosene) solutions at liquid nitrogen temperature. This luminescence can be used for the direct quantitative determination of uranium in the above solutions. The method is selective for uranium. The sensitivity of the method is 1×10^{-5} g/ml of uranium. The accuracy of the determination is ±1.5% at the uranium concentration of about 1×10^{-3} g/ml. (auth)

16427 NEW EXTRACTION-PHOTOMETRIC METHOD FOR THE DETERMINATION OF URANIUM(VI). Kovalenko, P. N.; Shchemeleva, G. G.; Sokolova, L. S. (Rostov-on-the Don State Univ., USSR). Zh. Anal. Khim., 22: 1845-9(Dec. 1967). (In Russian).

The interaction of uranium(VI) with crystal violet in the presence of sodium benzoate has been studied. Optimum conditions for the photometric determination of uranium(VI) have been found, the dissociation constant of the compound formed, and the molar extinction coefficient has been calculated; the ratio of uranium and crystal violet in the extracted compound has been determined. A method has been developed for the extraction-photometric determination of uranium in solutions of uranium salts and uranium—nickel alloys. (auth)

16428 BISMUTHOLS AS ANALYTICAL REAGENTS. COMMUNICATION 1. EXTRACTION-PHOTOMETRIC DETERMINATION OF TELLURIUM(IV) BY MEANS OF 5-MERCAPTO-3-(NAPHTHYL-2)-1,3,4-THIADIAZOLTHION-2. Busev, A. I.; Simonova, L. N. (Moscow State Univ.). Zh. Anal. Khim., 22: 1850-6(Dec. 1967). (In Russian).

The interaction of tellurium(IV) ions with 5-mercapto-3-(naphthyl-2)-1,3,4-thiadiazolthione-2 has been studied. It has been found that a yellow compound is formed in an acid medium, which is only slightly soluble in water and can be extracted with chloroform, benezene, and cyclohexanone. The maximum absorption of the extracts is at 328 nm. The molar ratio of tellurium and the reagent in the compound equal to 1:4 has been found by the isomolar series method, by the saturation method, and by elemental analysis. The true values of the molar extinction coefficients of the complex compound and the reagent have been found to be 29,550 (λ_{max} = 326 nm) and 9250 (λ_{max} = 330 nm). The optical density of the chloroform extracts of the compound was directly proportional to the concentrations from 1 to 50 μg/ml of tellurium. The reagent has been used for the extraction-photometric determination of tellurium in lead concentrate and in sulfur. (auth)

16429 SPECTROGRAPHIC ANALYSIS OF HIGH PURITY AMORPHOUS BORON. Degtyareva, O. F.; Ostrovskaya, M. F. Zh. Anal. Khim., 22: 1863-9(Dec. 1967). (In Russian).

A method has been developed for the simultaneous determination of 32 element impurities in amorphous boron with a sensitivity of 3×10^{-5} to 1×10^{-2}%. The relative error is 6 to 20%. A study has been made of the effects of the shape of carbon electrodes on the excitation of impurities of different volatility. The relationship has been established between the line intensity and the concentration of carbon powder and Li_2CO_3 or AgCl. The method permits using a dc or ac arc for the analysis. There is no need for chemical treatment of the samples. The analysis can be carried out by means of the ISP-22 and ISP-51 spectrographs of medium dispersion with a F-270 camera. (auth)

16430 QUANTITATIVE DETERMINATION OF BARIUM IN THE PRESENCE OF STRONTIUM, CALCIUM, AND MAGNESIUM BY MEANS OF PYROMELLITIC ACID. Vasyutinskii, A. I.; Mogilevskaya, V. I. (Odessa Polytechnical Inst.). Zh. Anal. Khim., 22: 1895-7(Dec. 1967). (In Russian).

A method has been developed for the quantitative separation of Ba^{2+} from Sr^{2+} (1:1), Ca^{2+} (1:10), and Mg^{2+} (1:19) by precipitation with pyromellitic acid followed by the complexonometric determination of barium. (auth)

16431 USE OF A HOLLOW CATHODE DISCHARGE FOR THE DETERMINATION OF DEUTERIUM IN TITANIUM. Berezin, I. A.; Sten'gach, I. N. Zh. Anal. Khim., 22: 1897-8(Dec. 1967). (In Russian).

By means of a hollow cathode discharge, from 1 to 100 cm^3/g of deuterium in titanium samples has been determined with a relative error of 15 to 30%. (auth)

16432 DETERMINATION OF CARBON IN PURE IRON BY IRRADIATION WITH γ PHOTONS. Revel, Gilles; Chaudron, Thierry; Debrun, Jean-Luc; Albert, Philippe (CNRS, Vitry, France). Compt. Rend., Ser. C, 226: 322-4(Jan. 29, 1968). (In French).

After irradiation in a beam of gamma photons, carbon was extracted from iron by combustion in an oxygen stream. The activity of the $^{11}C^*$ proceeding from the sample was compared with that of a graphite standard. The contents of carbon found in the purest samples were less than 2×10^{-6}. In these same samples the contents found by gas chromatography were in the range 2 to 10×10^{-6}. (tr-auth)

16433 ASSESSMENT OF THE EFFICIENCIES AND COSTS OF LIQUID SCINTILLATION MIXES FOR AQUEOUS TRITIUM SAMPLES. White, David R. (Royal Marsden Hospital, Surrey, Eng.). Int. J. Appl. Radiat. Isotop., 19: 49-61(Jan. 1968).

An experimental reassessment was made of the counting efficiencies of a number of liquid scintillation systems for aqueous tritium samples using a Packard Tri-Carb spectrometer. Toluene blended, dioxane and dioxane blended mixes were measured, together with a number of commercial systems. Counting efficiencies and costs are presented for all the systems, together with information on the effects of different grades of chemicals. Figures of merit are computed, and it is hoped that the choice of the most suitable system for a given counting problem is made more straightforward. (auth) (UK)

16434 DETERMINATION OF Ce(III) BY TITRATION WITH $K_3Fe(CN)_6$ IN STRONGLY BASIC SOLUTION. Basinska, Halina; Soboczynska, Janina (Copernicus Univ., Torun). Chem. Anal. (Warsaw), 12: 973-80(1967). (In Polish).

A new method for direct titration of Ce^{3+} with $K_3Fe(CN)_6$ in strongly basic solution (4$\underline{N}$ in KOH) was developed. The titration end point was determined potentiometrically or with the use of murexide as an indicator. Cerium content of 0.001 to 0.3 g in 5 to 20 ml of the analyzed sample was determined by this method. The error of determination did not exceed ±1 and +0.5% for potentiometric and indicator method, respectively as compared to the results of gravimetric method. In the case of indicator analysis with the use of murexide, there was a sharp change of color from violet-red to yellow at the titration end point. Analysis time amounted to 30 and 15 minutes in the case of potentiometric and indicator method, respectively. The method described can be used to the direct determination of cerium in the presence of any quantities of the following ions: Mg^{2+}, Zn^{2+}, Pb^{2+}, Al^{3+}, Sn^{4+}, NO_3^-, Cl^-, SO_4^{2-}, SiO_3^{2-} as well as in the presence of small quantities of Fe^{3+} and Cu^{2+} ions. The method can be used for the determination of cerium in alloys, for example, in lighter flints. As little as 0.2 g of the material is needed for the determination. (auth)

16435 ANALYTICAL APPLICATION OF THIOCYANOBISMUTHITES. IV. GRAVIMETRIC DETERMINATION OF CESIUM AS THE CESIUM–SODIUM HEXATHIOCYANO–BISMUTHITE. Cyganski, Andrzej (Politechnika, Lodz, Poland). Chem. Anal. (Warsaw), 12: 1103-6(1967). (In Polish).

A new gravimetric method for the determination of cesium was devised. Cesium is precipitated as $Cs_2Na[Bi(SCN)_6]$ from a small volume of solution by addition of $Na_3[Bi(SCN)_6]$ saturated with $Cs_2Na[Bi(SCN)_6]$. Cs can be determined by this method in amounts of 40 to 240 mg in the presence of ammonium and potassium ions. Chlorides, sulfates, and rubidium ions interfered with the determination. (auth)

16436 RADIOMETRIC METHOD FOR THE DETERMINATION OF Zr IN ZIRCONIUM-BEARING SANDS. Dziunikowski, Bohdan; Holynska; Barbara; Stachurski, Jozef (Inst. of Nuclear Techniques, Krakow. Dept. of Mechanical Processing, Krakow). Chem. Anal. (Warsaw), 12: 1107-11(1967). (In Polish).

A nondispersive x-ray fluorescence method for the determination of Zr in zirconium-bearing sands was developed. Because a strong matrix effect due to variable contents of Fe and Ti exists, a method for overcoming this effect was worked out. The intensity of both x-ray fluorescence radiation of Zr and gamma radiation transmitted through the sample was measured. A ^{109}Cd x-ray source for fluorescence measurements and ^{241}Am gamma source for absorption measurements were used. A nomographic interpretation of measurement data was used. The concentration range of Zr in sands was 0 to 2%. The relative error (one standard deviation) of the determination of Zr was approximately 3.0% when the content of Ti in sands did not exceed 3%. (auth)

16437 APPLICATION OF MODIFIED COUNTER-CURRENT TECHNIQUE TO THE DETERMINATION OF TUNGSTEN IN MOLYBDENUM. Kallmann, S.; Hobart, E. W.; Oberthin, H. K. (Ledoux and Co., Teaneck, N. J.). Anal. Chim. Acta, 41: 29-34(Apr. 1968).

More than trace amounts of molybdenum interfere in the determination of tungsten by the dithiol method. A simplified counter-current extraction method is described which allows the determination of 5 ppM or more of tungsten in a molybdenum matrix. The optimum conditions for the separation were a 6 M HCl–2.4 M HF medium and methyl isobutyl ketone as extractant; the percentage extractions in a single pass were 85% and 15% for molybdenum and tungsten, respectively. (auth)

16438 APPLICATION OF X-RAY DIFFRACTION ANALYSIS TO URANIUM CERAMICS. PART II. QUANTITATIVE ANALYSIS OF THE URANIUM CARBIDES. Conti, R.; Toussaint, C. J.; Vos, G. (EURATOM-CCR, Ispra, Italy). Anal. Chim. Acta, 41: 83-91(Apr. 1968).

Different x ray diffractometer methods are proposed for the determination of uranium carbides in binary and multicomponent mixtures (direct methods, internal standard, and active dilution method). The relative standard deviation was found to be 2%. Limits of detection for UC_2 and UO_2 in UC were about 0.04%. Calculations showed that the UC_2 in the samples used contained 9.00 and 9.28 ± 0.04 wt % of combined carbon, corresponding to $UC_{1.96\pm0.01}$ and $UC_{2.03\pm0.01}$. (auth)

16439 DEVELOPMENT OF FLUORIDE-SENSITIVE MEMBRANE ELECTRODES. PART I. MEMBRANES CONTAINING THORIUM, LANTHANUM, OR CALCIUM FLUORIDE. Macdonald, A. M. G.; Toth, K. (Univ. of Birmingham, Eng.). Anal. Chim. Acta, 41: 99-106(Apr. 1968).

Fluoride-sensitive membrane electrodes of the Pungor type are described. In these electrodes, a fluoride precipitate is incorporated in a silicone rubber membrane; fluorides of thorium, lanthanum rare earths, and calcium have been examined. The method of preparing the precipitate is important; an excess of metal is vital for correct functioning of the final electrode. The most reliable results were obtained with calcium fluoride electrodes, though their sensitivity was less than that of the best lanthanum fluoride electrodes. With these electrodes, linear responses were obtained in the 10^{-2} to 10^{-4}M fluoride range. (auth)

16440 SPECTROPHOTOMETRIC DETERMINATION OF NIOBIUM IN ZIRCONIUM WITH 4-(2-PYRIDYLAZO)RESORCINOL. Pakalns, P.; Ivanfy, A. B. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). Anal. Chim. Acta, 41: 139-45(Apr. 1968).

The direct spectrophotometric determination of niobium in zirconium alloys with 4-(2-pyridylazo)resorcinol is described. Samples are dissolved in hydrofluoric–sulfuric acid mixture and the color developed without the removal of fluoride. In the presence of EDTA only Co^{2+}, Ta^{5+}, and V^{5+} cause serious interference. The molar absorptivity is 3.67×10^4 in the presence of 1 mg of zirconium, and Beer's law is obeyed up to 1.0 μg Nb/ml. The method can be applied to zirconium alloys containing as little as 0.005% niobium. (auth)

16441 NEUTRON ACTIVATION ANALYSIS OF HIGH-PURITY SELENIUM. PART II. DETERMINATION OF TELLURIUM. Ballaux, C.; Dams, R.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 41: 147-54(Apr. 1968).

Neutron activation determination of 15 to 25 ppB of tellurium in selenium can be done by irradiating 100-mg samples for 4 days at a neutron flux of 6×10^{12} n cm^{-2} sec^{-1}. The daughter isotope of ^{131}Te, ^{131}I, is separated by distillation and extracted into carbon tetrachloride. Finally the silver iodide precipitate is measured by β,γ-coincidence counting. The standard deviation is 3 to 7%. (auth)

16442 DETERMINATION OF PHOSPHORUS IN ROCKS BY NEUTRON ACTIVATION. Brunfelt, A. O. (Univ. of Oslo); Steinnes, E. Anal. Chim. Acta, 41: 155-8(Apr. 1968).

The neutron activation method described for the determination of phosphorus has, in addition to G-1 and W-1, been applied to some recent primary standard rock samples from the U.S. Geological Survey and to tonalite T-1 from the Geological Survey of Tanganyika. The precision of the method appears to be of the order ±5% for P_2O_5 contents above 0.1%. (P.C.H.)

16443 STUDY OF INTERFERENCES IN THE SPECTROPHOTOMETRIC DETERMINATION OF TITANIUM WITH SULFOSALICYLIC ACID. Qureshi, Mohsin; Rawat, Jagdish P.; Khan, Fahmida (Aligarh Muslim Univ., India). Anal. Chim. Acta, 41: 164-6(Apr. 1968).

The sulfosalicylic acid method for the determination of Ti was investigated in detail with regard to the proper wavelength, the interferences of common anions, less common cations, and effects of temperature. The possible masking of interfering ions was also studied. Ions that interfered when present in 100-fold excess were Bi^{3+}, Ce^{4+}, Co, Cr, Cu, Mo, Pd, Pt, Te, U, V, W, citrate, tartrate, $S_2O_3^{2-}$, and F^-. When the absorbance is measured at 355 nm instead of 445 nm the method becomes 10 times as sensitive. It therefore appears that this is probably the best method for the determination of Ti. (P.C.H.)

16444 TITRIMETRIC DETERMINATION OF BERYLLIUM IN PRESENCE OF LARGE AMOUNTS OF URANIUM. Uny, G.; Tran Van Danh; Spitz, J. (Centre d'Etudes Nucleaires, Grenoble, France). Anal. Chim. Acta, 41: 173-5(Apr. 1968). (In French).

Studies were made on the effects of H_2O_2 on the determination of Be alone or in the presence of U. Statistical studies on the results obtained showed that the volumetric determination of Be remains possible even in the presence of U, the influence of this latter element having been previously eliminated by complexation with H_2O_2 in the form of the peroxouranic type. The presence of H_2O_2 in small excess entrained some variations in the final results that did not exceed the limits of the scattering observed for measurement. It was concluded that the method proposed permits the determination of Be in the presence of quantities of U not exceeding 500 mg, without separation and with an acceptable precision. This is in the order of 1 to 3% for quantities of Be determined between 2 and 20 mg. (P.C.H.)

16445 USE OF CHELATING ION EXCHANGE IN THE DETERMINATION OF MOLYBDENUM AND VANADIUM IN SEA WATER. Riley, J. P.; Taylor, D. (Univ. of Liverpool). Anal. Chim. Acta, 41: 175-8(Apr. 1968).

A simple and rapid photometric method is described for the determination of V and Mo in seawater. These elements can be quantitatively eluted and separated from other trace metals taken up by Chelex-100 resin with 20 ml of 2 N ammonia solution. The results of analyses showed that the accuracy of the methods was satisfactory. (P.C.H.)

16446 DETERMINATION OF LANTHANUM, HOLMIUM, AND URANIUM IN THEIR TUNGSTEN BRONZES BY THERMAL NEUTRON ACTIVATION. Wechter, Margaret A.; Voigt, Adolf F. (Ames Lab., Iowa). Anal. Chim. Acta, 41: 181-4(Apr. 1968).

The concentrations of La, Ho, and U in their tungsten bronzes were determined by γ-scintillation spectrometry, following irradiation with thermal neutrons. In all cases ^{187}W, produced by the reaction $^{186}W(n,\gamma)^{187}W$, was the major interference. For all irradiations standard samples were irradiated simultaneously with the bronze samples. The sensitivity of the method is sufficient to permit accurate analyses to considerably lower levels, of the order of 0.1% for La and U and 0.5% for Ho. (P.C.H.)

16447 IMPROVED END-POINT FOR THE DETERMINATION OF FLUORIDE WITH THORIUM NITRATE. Selig, Walter (Univ. of California, Livermore). Analyst, 93: 118-20(Feb. 1968).

The end-point for titrimetric determination of fluoride with thorium nitrate was improved by the use of methylthymol blue indicator. Up to 10 mg of fluoride can be determined in a solution buffered with glycine–perchlorate at pH 3.35. (auth) (UK)

16448 DETERMINATION OF TRACES OF NITROGEN IN REFRACTORY METALS AND ALLOYS BY HYDROFLUORIC ACID–PHOSPHORIC ACID–POTASSIUM DICHROMATE DECOMPOSITION AND INDOPHENOL PHOTOMETRY. Kallmann, Silve; Hobart, Everett W.; Oberthin, Hans K.; Brienza, Walter C. Jr. (Ledoux and Co., Teaneck, N. J.). Contract F3361-67-C-1524. Anal. Chem., 40: 332-5(Feb. 1968).

A method is described for the determination of nitrogen in refractory metals by the dissolution of up to 5g samples in a $K_2Cr_2O_7-HF-H_3PO_4$ mixture followed by steam distillation of the NH_3 and subsequent spectrophotometric determination with indophenol. The dissolution mixture did not oxidize the NH_3 to N_2, was highly efficient as a dissolution reagent for large chunks of the refractory metals, and gave a blank of <0.5 μg of N. (B.L.M.)

16449 DETERMINATION OF MOLYBDENUM IN SPECIAL INDUSTRIAL MATERIALS. Sajo, Istvan; Forster, Walter; Rudiger, Helga; Sipos, Albertne (Eisenforschunginstitut, Budapest. Forschunginstitut fuer Metallische Spezialwerkstoffe, Dresden). Neue Huette, 12: 500-2(1967). (In German).

For the determination of Mo in alloys containing Ti and Al, the Mo was separated from interfering elements by separation on ion exchangers before precipitation with Complexone-III. A thermometric method, in which the heats of reaction were measured, was then developed for the determination of Mo. The principle of the method is described, and details of the method are given. The results obtained are compared with a gravimetric determination by oxine precipitation after ion exchange separation. The agreement is good, and the advantage of the thermometric method is that it requires no preliminary separation. (J.S.R.)

16450 AUTOMATED NEUTRON-ACTIVATION ANALYSIS OF BIOLOGICAL MATERIAL WITH HIGH RADIATION LEVELS. Samsahl, K. (Aktiebolaget Atomenergi, Nykoping, Sweden). Analyst, 93: 101-6(Feb. 1968).

A method was developed for the chemical separation and subsequent γ-spectrometric analysis of the alkali metals, the alkaline earths, the rare earths, chromium, hafnium, lanthanum, manganese, phosphorus, scandium, and silver in neutron-activated biological material. The separation steps, which are fully automatic, are based on a combination of ion-exchange and partition chromatography, and require 40 minutes for their completion. (auth) (UK)

16451 A GRAVIMETRIC METHOD FOR THE DETERMINATION OF MIXED OXIDES (NIOBIUM AND TANTALUM PENTOXIDES) IN NIOBIUM–TANTALUM MINERALS. Pollock, J. B. (Geological Survey and Mines Dept., Entebbe, Uganda). Analyst, 93: 93-6(Feb. 1968).

A method is described in which the sample is dissolved by repeated evaporation with hydrofluoric acid, and the final solution then considerably diluted and filtered. The insoluble residue is reserved for determining tin, uranium, and thorium, if required, and the filtrate is made up to a fixed volume. A suitable aliquot is evaporated to fumes with sulphuric acid, diluted and the combined oxides precipitated with tannin. A second aliquot may be used, after evaporation to fumes with sulphuric acid, for determining niobium pentoxide by Pickup's method. (auth) (UK)

16452 SUPPRESSION OF SOME INTERFERENCES IN THE DETERMINATION OF MOLYBDENUM BY ATOMIC-ABSORPTION SPECTROSCOPY IN AN AIR-ACETYLENE FLAME. David, D. J. (Commonwealth Scientific and Industrial Research Organization, Canberra, Australia). Analyst, 93: 79-82(Feb. 1968).

Earlier published work on the determination of molybdenum with an incandescent air—acetylene flame showed that aluminum could be used effectively to suppress the interferences of such elements as strontium, calcium, manganese and iron, but this was not confirmed for manganese and iron by other workers. Ammonium chloride, subsequently shown to be effective in the suppression of manganese and iron interference in metallurgical analysis, suppressed the interferences of alkaline earth chlorides, but had no effect on a severe interference by calcium ion, sulphate, and phosphate in combination. As aluminium ion suppressed this interference, a mixture of aluminium and ammonium chlorides is suggested for general application. (auth) (UK)

16453 PRESENT STATUS OF ACTIVATION ANALYSIS APPLICATIONS IN CRIMINALISTICS. Jervis, R. E. (Univ. of Toronto, Can.). Radioisotopes (Tokyo), 17: 18-32(Jan. 1968).

Applications of activation analysis in forensic science are reviewed. Toxicology studies involving arsenic determination in tissues, mercury determination in tissues and food, thallium determination in hair are described. Wounds, holes in clothing, and deposits on suspects hands were identified as arising from gun shots through the detection of increased traces of barium and antimony on bone, skin, or adjacent surface areas. Different specimens of a class of similar materials such as paints, glass, narcotic drugs, fibers, or human head hair were characterized by multi-element activation analyses thereby revealing patterns of trace constituents that were incorporated as a result of the particular source or past history of the specimen. (84 references). (M.C.G.)

16454 A METHOD FOR THE ESTIMATION OF ^{45}Ca IN BIOLOGICAL SAMPLES USING A SPECIFIC ADSORBANT. Gibbons, R. A.; Sellwood, R. (Agricultural Research Council, Compton, Eng.). Int. J. Appl. Radiat. Isotop., 19: 129-34(Feb. 1968).

Calcium-45 may be specifically adsorbed from solution by the ion-exchange medium "Chelex 100," a cross-linked polystyrene in which the functional groups are iminodiacetic acid residues. A procedure was developed making use of this and enabling ^{45}Ca to be simply and conveniently estimated with efficiencies in the region of 50%. The method is primarily useful where the isotope is present in dilute solution at moderate (0.1 μc/g) specific activities, as in the radioassay of plasma or urine samples. A method for the routine assay of such samples is presented, and some studies are described indicating where the scope of the method may be extended to meet other problems of radiocalcium estimation. The technique may be further exploited by using other specific absorbants, where these are available; for example ^{35}SO$_4$ is specifically taken up by zirconium hydroxide. The possibilities of counting ^{35}S in this way are briefly indicated. (auth) (UK)

16455 DETERMINATION OF ^{234}U/^{238}U OF URANIUM IN NATURAL MATERIALS. Umemoto, Shunji (Okayama Univ., Japan). Radiochim. Acta, 8: 107-11(Nov. 1967).

Uranium in natural materials was separated and purified chemically, and about 100 μg of the uranium was fixed on a silver disk by electrodeposition. An α spectrometer with a gridded ionization chamber was used for counting the activity of the uranium on this silver disk. The α spectrum obtained was divided into four regions, and the total counts of each region were designated as A, B, C, and D from high to low energy. Based on the assumptions of decrease in geometric progression and linear decrease for the far tail of the spectra, two kinds of equation were derived to calculate the ratio ^{234}U/^{238}U (= r). Both equations are applicable for natural uranium. (auth)

16456 MEASUREMENT OF ^{32}P ACTIVITY IN A LIQUID SCINTILLATION COUNTER WITHOUT THE USE OF SCINTILLATOR. Clausen, Torben (Univ. of Aarhus, Denmark). Anal. Biochem., 22: 70-3(Jan. 1968).

Utilization of Cherenkov radiation for measurement of ^{32}P is described. The presence of HNO_3, H_2SO_4, KOH, and NaOH did not affect the counting efficiency, and the presence of NaCl, KCl, HCl, and ethanol increased the efficiency only slightly. Some advantages of the method are: samples can be pipetted directly into counting vials, volumes up to 22 ml of aqueous solution can be counted, background is low, and there is no expense for scintillators. (D.H.M.)

16457 MEASUREMENT OF ^{45}Ca IN BIOLOGICAL FLUID. Oxby, C. B.; Kirby, P. A. (Medical Research Council, Leeds, Eng.). Int. J. Appl. Radiat. Isotop., 19: 151-2(Feb. 1968).

A method of measuring ^{45}Ca in biological fluids is described which enables 8 ml of the sample to be counted directly in a liquid scintillation spectrometer without chemical preparation. It is described with reference to plasma samples, but it can also be applied to re-dissolved faecal ash, urine samples, and calcium chloride solutions containing 1 g of calcium. The sample is made into a gel with a toluene-based scintillator, using an emulsifying agent, and is counted in the liquid scintillation spectrometer. Calibration involves the use of an external standard that allows for the effect of quenching. (auth) (UK)

16458 SPECTROGRAPHIC DETERMINATION OF RADIOGENIC OSMIUM. Egizbaeva, K. E.; Kalinin, S. K.; Fain, E. E. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 7: 924-7(Dec. 1967). (In Russian).

Descriptions are given of the spectrographic determination of radiogenic osmium produced by β decay of ^{187}Re. An electric d-c arc was used as a spectrum excitation source of osmium. Isotopic analysis was carried out with a charge in a hollow cathode in an air atmosphere. A DFS-3 spectrograph and IT-28-30 interferometer were used for recording the spectrum. Analytical lines 4420.47 and 4260.854 Å were studied. The order of experimental error was 10 to 12%. (R.V.J.)

16459 METROLOGICAL PROBLEMS OF DETERMINING THE ACTIVITY OF LOW-CONCENTRATION RADIUM-CONTAINING SOLUTIONS BY ALPHA-SCINTILLATION CHAMBERS. Hoehle, R.; Schuh, U. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Isotopenpraxis, 3: 470-4(Dec. 1967). (In German).

The various techniques and detectors used for measuring the activity of low-concentration radium-containing solutions are described. The conditions of attaining high sensitivity of detection of the scintillation chambers are discussed. The influence of the field and the position of the alpha-sensitive detecting layer were investigated for scintillation chambers of variable size. The results obtained by using a scintillation chamber of 50 cm^3 of volume are presented, which enabled a lower detection limit of 10^{-14}g Ra by using an enrichment technique for the emanation. (auth)

16460 ^{131}I-DETERMINATION IN THE PRIMARY COOLING WATER CIRCUIT OF NUCLEAR REACTOR WWR-S. Csada, Imrene; Erdeyne-Schneer, Anna. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 16: 53-6(1968). (In Hungarian).

The total iodine and ^{131}I concentrations in the primary cooling water circuit of the WWRS-type reactor were determined and found to be a few ppB and 10^{-4} μCi/ml, respectively. The experimental technique is described. (auth)

16461 MECHANISM OF ENERGY TRANSFER FROM AROMATIC COMPOUNDS TO RARE EARTH IONS. Morina, M. F.; Ermolaev, V. L.; Khundenskii, Yu. K. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 349-50(Oct. 1967).

Translated from Opt. Spektrosk., 23: 643-5(Oct. 1967).

A quantitative study of the sensitization of europium and terbium inorganic salt luminescence by aromatic ketones was made and some transfer rate constants were determined. The intensities (relative yield) of sensitized luminescence in vacuum and in air were investigated as a function of rare earth ion and donor concentration. Graphic data are presented for three sensitizers (benzophenone, 2-naphthyl methyl ketone, and acetophenone). (D.H.M.)

16462 RADIOCHELATOMETRIC DETERMINATION OF LEAD. Konecny, J.; Tolgyessy, J. (Slovak Technical Univ., Bratislava). Isotopenpraxis, 3: 479-82(Dec. 1967).

A 10^{-3}M EDTA solution, Dowex W-X2 cation exchanger, and ^{65}Zn radionuclide were used as the titrant, the separator of components, and the nonisotopic indicator, respectively. The method, the procedure, and the results obtained are described. In this way 0.83 to 1.40 μg-equiv of lead was determined in model solutions. The method can also be used to determine submicrogram amounts of lead. (auth)

16463 SPECTROPHOTOMETRIC DETERMINATION OF RHENIUM WITH DIACETYLMONOXIME. Narayanan, A.; Subbaraman, P. R. (National Chemical Lab., Poona). Indian J. Chem., 5: 436-9(Sept. 1967).

Perrhenate as well as molybdate react with 2,3-butanedione oxime in the presence of stannous chloride to give intensely colored solutions. The reaction with perrhenate occurs only below a hydrochloric acid concentration of 1N whereas that with molybdate proceeds at higher acid concentrations. Based on these observations, quantitative spectrophotometric procedures have been developed both for rhenium and molybdenum. The procedure for rhenium tolerates microgram levels of molybdenum, vanadium, and copper. These elements, when present in higher amounts, are readily separated from rhenium by extraction with quinoline before developing the rhenium color. The rhenium–diacetylmonoxime complex has a molar extinction of 19000 at 500 mμ. The corresponding molybdenum complex has a molar extinction of 8000 at 490 mμ, but copper, iron, vanadium, and rhenium interfere in the molybdenum procedure. (auth)

16464 ANALYSIS OF URANYL SOLUTIONS BY THE METHOD OF REFLECTIONS OF β RADIATIONS. II. ANALYSIS OF SOLUTIONS OF URANYL NITRATE IN THE PRESENCE OF Al, Fe, Co, Ni, Cu, AND Pb. Marcu, Gh.; Tolea, Fl.; Sacelean, V. (Univ. Babes-Bolyai, Cluj). Rev. Roum. Chim., 12: 653-7(June 1967). (In French).

It was established that, in the case of binary systems, uranium can be determined in a solution by the reflection of beta radiation with a maximum error of ±0.70% in the presence of 0 to 50 g/l of metal where the metal is Al, Fe, Co, Ni, or Cu, and with a maximum error of ±2.00% in the presence of 0 to 15 g of Pb/l. In the complex mixtures of uranium with Al, Fe, Co, Ni, Cu, and Pb at a concentration of 0 to 50 g/l, uranium can be determined with an error of ±2.5%. It was concluded that the method can be used with success for the rapid continuous analysis of dissolved minerals with a minimum content of uranium of 4 g/l with a maximum error of ±0.70%. (tr-auth)

16465 RADIOMETRIC DETERMINATION OF THE VOLUME CHANGE ON MIXING IN THE LIQUID CADMIUM–CADMIUM CHLORIDE SYSTEM. Moscinski, J. (Inst. of Nuclear Technique, Krakow); Suski, L. J. Phys. Chem., 72: 441-7(Feb. 1968).

A relative method for the determination of molar volume in the Cd–$CdCl_2$ solution with respect to molar volume of pure $CdCl_2$ by measurement of γ absorption is described. The isotope ^{203}Hg was used as a radiation source. Absorption coefficients of pure components of the solution and dependence of absorption of γ rays on the composition of the solution were determined for this source and a given geometry of the experimental setup. The molar volumes of the Cd–$CdCl_2$ solutions determined by this method for three different temperatures are in good agreement with the data available in the literature obtained by classical methods. Accuracy of the method and sources of errors are discussed. The volume effect of mixing, positive for these solutions, was derived. (auth)

16466 THE ANALYSIS OF ALUMINUM ALLOYS BY ATOMIC ABSORPTION SPECTROSCOPY WITH SPECIAL REFERENCE TO THE DETERMINATION OF CHROMIUM AND ZIRCONIUM. Wilson, L. (Aeronautical Research Labs., Melbourne). Anal. Chim. Acta, 40: 503-12(Mar. 1968).

The analysis of aluminum-base alloys for silver, copper, magnesium, zinc, chromium, and zirconium by atomic absorption spectroscopy is described. The use of hot flames (nitrous oxide–acetylene) allows improvements to earlier procedures for such analyses. Sensitivities are increased, interferences reduced, and the determination of more refractory elements, e.g., Cr and Zr, becomes possible. Hollow-cathode lamps with greatly increased resonance-line intensities are used for the determination of chromium and zirconium. (auth)

16467 TISSUE COPPER DETERMINATIONS BY NEUTRON ACTIVATION ANALYSIS. Todd, A. P.; Thorpe, M. E. C.; Rosenoer, V. M. (Royal Free Hospital, London). J. Clin. Pathol., 20: 276-9(May 1967).

A method is described for Cu determination in tissue samples by neutron activation analysis. The results obtained for normal liver Cu estimations compared favorably with results obtained by conventional methods. Liver tissue was taken from normal rats, rats previously injected with Cu, regenerated rat livers, and human cadavers. The samples and standard were then activated in a reactor at A.E.R.E., Harwell, using a neutron flux of 10^{12} n/cm^2/sec and an irradiation time of 13 hr. The reaction taking place with thermal neutrons was $^{63}_{29}\text{Cu} + ^{1}_{0}\text{n} \rightarrow ^{64}_{29}\text{Cu} + \gamma$. The neutron flux was tested for homogeneity by a series of $CuSO_4$ standards of varying weights; the activity per gram fell within the accepted statistical limits. Within five hr of removal from the pile, the samples were returned and ready for processing by Dowex A1 chromatography. In a series of digested standards, 98.9 to 101% was recovered on the columns and no ^{64}Cu was eluted in the washings. Spectral analysis of the columns for both tissues and standards indicated peaks at 0.511 MeV and 1.02 MeV, which were identifiable with ^{64}Cu. The 1.02-MeV peak was not seen on the flat NaI(Tl) crystal as it is the positron annihilation coincidence peak. This enabled the assessment of the nonpositron–emitting impurities behind the peak to be estimated at less than 3% of the total peak counts at 1.02 MeV. The rest of the spectrum from 0.6 MeV upwards did not exceed 1% of the 0.511-MeV peak total counts. In particular, the absence of significant peaks at 1.37 and 2.75 MeV indicated that no ^{24}Na was present. The method described separates Cu from Ca, Mn, and Na but is not satisfactory for the separation of ^{69m}Zn and ^{65}Zn. However, it is possible to differentiate ^{65}Zn because of its longer half-life and ^{69m}Zn because of the different ratio between the 0.511-MeV and 1.02-MeV channels. (BBB)

16468 STUDY OF METALLIC AND DIELECTRIC SPUTTERING BY NEUTRON ACTIVATION AND ELECTRON MICROPROBE ANALYSIS. Hasseltine, Eric Hermon. Berkeley, Calif., Univ. of California, 1967. 68p.
Thesis.

A neutron activation technique suitable for the determination of trace amounts of short lived radioisotopes was developed and applied to the investigation of cesium ion sputtering of aluminum and aluminum oxide. The sputtering yields were measured as functions of cesium ion energy, crystal temperature, and the partial pressure of oxygen in the chamber. In all measurements the ion beam was normal to the target surfaces, which for aluminum were the (100) and (110) faces, and for aluminum oxide, the (001) face. For the dielectric, aluminum oxide, techniques for neutralizing the target surface and monitoring the ion beam current were devised. The sputtering yield increased monotonically for both substances in the 1 to 10 keV ion energy range, and was unaffected by the oxygen background whenever the ratio of the oxygen molecular flux arriving at the target surface to the sputtered atom flux leaving the surface was less than 0.1. At higher values of the flux ratio, the aluminum yield decreased sharply and eventually reached a saturation value. The aluminum oxide yield decreased slightly and approached a saturation value which coincided with that for aluminum. This suggests that a surface film of Al_2O_3 was maintained on the aluminum surface at the higher flux ratios. No temperature effect was found for sputtering aluminum between 77°K and 475°K. For aluminum oxide the yield decreased with increasing temperature. This behavior is ascribed to a high rate of defect removal by annealing in aluminum and a low, temperature dependent rate in aluminum oxide. A technique of scanning highly polished surfaces for trace impurities with an electron microprobe was developed to measure the angular distribution of sputtered aluminum atoms. The sputtered atoms were collected on copper cubes. The distribution was measured in the (001) plane as a function of energy and temperature. Peaks were noted at polar angles of 27° and 45° from the target surface. The distribution was only weakly affected by ion energy and temperature. (Disser. Abstr.)

16469 RADIOMETRICKE TITRACIE. (Radiometric Titrations). Tolgyessy, Juraj. Bratislava, Vydavatelstvo Slovenskej Akademie Vied, 1966. 298p.

Fundamentals of the indicatory use of radioisotopes, principles of radiometric titration, development of radiometric titration methods, and systems of indicators used in the titrations are discussed. Theoretical bases of precipitation methods, modes of estimating end-points, phase separation methods, titration equipment and techniques, titrations in water-free solutions, and the determination of compounds are discussed. Radiometric titrations based on the formation of complexes are also discussed. Redox titrations, radiocoulometric titrations, titration methods based on the interaction of β- particles and the titrated system, and titration methods based on the use of radioactive kryptonates are analyzed. Applications of radiometric titration methods to precipitation and coprecipitation, the determination of the structure of compounds, the determination of the solubility product, and the determination of the specific activity of radioactive compounds are also considered. Determinations of individual compounds by radiometric titration are described. (J.G.B.)

16470 ADVANCES IN TRACER METHODOLOGY. VOLUME 4. A Collection of Papers Presented at the Eleventh Annual Symposium Held October 13–14, 1966, Boston, Mass. Rothchild, Seymour (ed.). New York, Plenum Press, 1968. 293p. (CONF-661061–(Vol.4)).

Nineteen papers presented at the conference are included under the following topics: labeled compounds, analytical techniques, and applications of labeled compounds. Separate abstracts were prepared for eight of the papers. (M.C.G.)

For abstracts of individual papers see: 16471–16476, 16487, and 16570.

16471 TRITIUM AND ^{14}C BY OXYGEN FLASK COMBUSTION. Davidson, Jack D.; Oliverio, Vincent T. (National Cancer Inst., Bethesda, Md.). Advan. Tracer Methodol. (U.S.), 4: 67-79(1968).

From 11th Symposium on Advances in Tracer Methodology, Boston. See CONF-661061–(Vol.4).

The entire oxygen flask combustion technique for determination of ^{14}C and tritium in biological materials is described. It was found that a 2-liter volume of oxygen can combust up to 300 mg of the usual dry organic material samples quantitatively and safely. An infrared light beam is used for ignition of the samples. The technique is not applicable to samples containing volatile radioactivity. (M.C.G.)

16472 THIN-LAYER CHROMATOGRAPHY RADIOASSAY: A REVIEW. Snyder, Fred (Oak Ridge Associated Universities, Tenn.). Advan. Tracer Methodol. (U.S.), 4: 81-104(1968).

From 11th Symposium on Advances in Tracer Methodology, Boston. See CONF-661061–(Vol.4).

Progress in the radioassay of analytical and preparative thin-layer chromatography (TLC) plates is reported. Autoradiography, fluorography, strip scanning, zonal scanning, and elution procedures are used for radiometric analysis of thin-layer chromatograms. Thin-layer chromatographic profiles of ^{14}C and ^{3}H determined by liquid scintillation zonal scans are superior to other methods in sensitivity and resolution. Recently the entire zonal-scan procedure was computerized so that the distribution of the chemical mass or radioactivity along a chromatographic lane can be graphed by an electroplotter directed by the TLC computer program. The program gives a direct printout of area percent, recovery, and counting efficiency. Corroborative TLC (argentation and borate) and gas-liquid chromatography techniques are described for the separation of glyceryl alkyl ethers according to unsaturation, isomeric form, and chain length. (auth)

16473 HIGH-RESOLUTION AUTORADIOGRAPHY OF ^{3}H-ESTRADIOL WITH UNFIXED, UNEMBEDDED 1.0μ FREEZE-DRIED FROZEN SECTIONS. Stumpf, Walter E.; Roth, Lloyd, J. (Univ. of Chicago). Advan. Tracer Methodol. (U. S.), 4: 113-25 (1968).

From 11th Symposium on Advances in Tracer Methodology, Boston. See CONF-661061-(Vol. 4).

In the development of an autoradiographic method for localization of labeled compounds, some procedures were found to introduce serious localization artifacts. Fixation, dehydration by freeze-substitution, and embedding-procedures were considered. The subcellular distribution of tritium-labeled estradiol was studied. Freeze-drying techniques were used. (M.C.G.)

16474 RADIOAUTOGRAPHY AS A TECHNIQUE IN TRACER METHODOLOGY. Nadler, N. J. (McGill Univ., Montreal). Advan. Tracer Methodol. (U.S.), 4: 127-31(1968).

From 11th Symposium on Advances in Tracer Methodology, Boston. See CONF-661061–(Vol.4).

Uses of autoradiography to investigate the metabolic turnover of substances in organs is discussed. This technique can be used for quantitative purposes by counting silver grains over selected regions. (M.C.G.)

16475 LIQUID SCINTILLATION COUNTING: AUTOMATED MATHEMATICAL FITTING AND USE OF CHANNELS RATIO METHODS BY COMPUTER PROGRAM. Blanchard, F. A.; Wagner, Mary R.; Takahashi, I. T. (Dow Chemical Co., Midland, Mich.). Advan. Tracer Methodol. (U.S.), 4: 133-43(1968).

From 11th Symposium on Advances in Tracer Methodology, Boston. See CONF-661061–(Vol.4).

Basic time and counting data can be taken directly from the liquid scintillation counter and entered into a computer for efficiency calculations. A program prepared in ALGOL 60 for use with a Burroughs B 5500 computer is described. For determination of counting efficiency each counting run contains a series of quenched standards. An equation relating efficiency to channel ratio is derived by the computer from the counting data of these standards. This is then used with subsequent unknowns. (M.C.G.)

16476 RECENT ADVANCES IN THE DOUBLE ISOTOPE DERIVATIVE ANALYSIS OF STEROIDS. Kliman, Bernard (Harvard Medical School, Boston). Advan. Tracer Methodol. (U.S.), 4: 227-39(1968).

From 11th Symposium on Advances in Tracer Methodology, Boston. See CONF-661061–(Vol.4).

Changes in methods and various applications of double-isotope derivative analysis are described. Selective assays of specific steroids are discussed as examples. (M.C.G.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 16565, 16566, 16581, 16590, 16629, 16654, 17157, and 18098.

16477 (AERE-R-5670) THE PREPARATION OF ^{153}Eu(II) OXIDE. Maude, B. M.; Wilkinson, K. L. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1968. 19p. Dep. CFSTI. UK 3s. 0d.

Various methods for the preparation of pure europium(II) oxide from europium(III) oxide, using natural europium, were studied. The method chosen for the europium isotopic preparation was carbon reduction of the ^{153}europium(III) oxide. (auth) (UK)

16478 (BNWL–680, pp 12-19) PROMETHIUM OXALATE SOLUBILITY STUDIES. Roberts, F. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Results of a series of equilibrium solubility measurements in oxalate solutions of widely varying nitric acid concentration are shown. No evidence of colloid formation was observed at pH's lower than 7. In this pH region, the precipitate was crystalline and settled rapidly. At pH higher than 7 the precipitate was very finely divided and difficult to separate. A small excess of oxalic acid could be tolerated, but a large excess increased promethium losses. Solubility increased with increasing temperature. (M.C.G.)

16479 (CEA-R-3168) ETUDE CINETIQUE DE LA REDUCTION PAR LE PEROXYDE D'HYDROGENE DU PLUTONIUM HEXAVALENT EN SOLUTION ACIDE. (Kinetic Study of Hexavalent Plutonium Reduction by Hydrogen Peroxide in Acid Solution). Lesigne, Bernard (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec. 1967. 34p. (In French). Dep.

The kinetics of the reduction of hexavalent plutonium by hydrogen peroxide was studied in perchloric, sulfuric, and nitric acids. The rate of reduction is proportional to the initial concentrations of plutonium and of hydrogen peroxide and is inversely proportional to the acidity. The values of the proportionality constant k were determined. They are very dependent on the temperature, on the ionic force, and on the nature of the anion of the acid medium. An interpretation is put forward, based on the experimental results, attributing an important role to the hydrolyzed species $PuO_2(OH)^+$ in the reduction kinetics. (auth)

16480 (COO–890-9) PREPARATION OF ^{14}C AND TRITIUM LABELED COMPOUNDS BY HYDROBORATION AND TRITIOBORATION PROCEDURES. Technical Progress Report, May 1, 1967–April 30, 1968. (Illinois Univ., Urbana. Radiocarbon Lab.). Contract AT(11-1)-890. 15p. Dep. CFSTI.

Palladium- and rhodium-catalyzed exchange reactions between tritium gas and organoboranes were investigated. The development of pyrolytic radiogas chromatography as a procedure to establish labeling patterns in milligram amounts of ^{14}C- and tritium-labeled 1-hexene is underway. Work is continuing on gas-chromatographic techniques for preparing high-level tritium-labeled organic compounds. (M.C.G.)

16481 (COO–1540-7) KINETIC ISOTOPE EFFECTS IN THE THERMAL CRACKING OF NEOPENTANE. Frank, Donald J. (Tulsa Univ., Okla. Dept. of Chemistry). Jan. 31, 1968. Contract AT(11-1)-1540. 28p. Dep. CFSTI.

Studies were made on the temperature dependence of the kinetic isotope effect and its relation to the mechanism of cracking of neopentane. Precise amounts of neopentane were pyrolyzed at temperatures of 500, 525, 550, and 600°C for varying lengths of time and the isotopic composition of the methane relative to the parent material was determined. It was concluded that the temperature effect in the thermal cracking of hydrocarbons is relatively unimportant in isotope fractionation at temperatures of 500 to 600°C. The results suggest that the multiplicity of carbon–carbon bonds types available for breading, and isotope fractionation due to the cracking of decomposition products of the original hydrocarbon are the primary factors that determine the isotopic composition of methane produced during thermal cracking. (P.C.H.)

16482 (LA-3871) A BIBLIOGRAPHY ON NUCLEAR MAGNETIC RESONANCE OF INORGANIC FLUORIDES. Furnish, Jean (comp.) (Los Alamos Scientific Lab., N. Mex.). Dec. 1967. Contract W-7405-eng-36. 17p. Dep. CFSTI.

Three hundred and forty-six references from Chemical Abstracts, Volume 51 through 65, are presented. Inorganic fluorides alone, in solvents of any sort, and in complexes with organic and inorganic molecules are included. All references were indexed under "nuclear magnetic resonance" in Chemical Abstracts. Entries are arranged by year and then alphabetically by author's name. (M.C.G.)

16483 (MLM-1482) DISPROPORTIONATION OF Pu(IV). Silver, Gary L. (Mound Lab., Miamisburg, Ohio). Feb. 19, 1968. Contract AT(33-1)-Gen-53. 7p. Dep. CFSTI.

The stoichiometry of disproportionation of Pu(IV), corrected for small amounts of pentavalent plutonium generated by the disproportionation reaction in a few typical acids, is presented in tabular form. (auth)

16484 (ORNL-4075, pp 62-6) MOLTEN-SALT REACTOR PROCESSING. McNeese, L. E. (Oak Ridge National Lab., Tenn.).

Preliminary experiments in a recirculating equilibrium indicate that the relative volatilities of rare earth trifluorides, with respect to lithium fluoride, at 1000°C and 0.50 mm Hg are significantly lower than was previously thought. (auth)

16485 (ORO-3234-6) TRACER AND ISOTOPE EFFECT STUDIES IN ORGANIC CHEMISTRY. Annual Progress Report. Fry, Arthur (Arkansas Univ., Fayetteville. Dept. of Chemistry). Feb. 1, 1968. Contract AT(40-1)-3234. 23p. Dep. CFSTI.

Research is reported on the following topics: chlorine isotope effects in the hydrolysis of substituted benzoyl chlorides; effects of ^{14}C on peroxybenzoic acid oxidation of p-substituted acetophenones; isotope effects on timing of bond changes in rearrangements to positively charged carbon; isotope effects on the mechanisms of Curtis, Hofmann, and Lossen rearrangements; effects of ^{14}C on nucleophilic displacement reactions of substituted benzyl chlorides; mechanisms of acid-catalyzed rearrangements of carbonyl compounds; ^{18}O exchange between p-substituted benzophenones and water; ^{15}N exchange between substituted benzamides and ammonia; and deuterium tracer studies of the stereochemistry of carbene and carbenoid insertion reactions. (M.C.G.)

16486 (LA-tr-68-4) SOLUBILITY OF URANIUM PEROXIDE. Nikolaev, A. V.; Durasova, S. A. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 3, 9-13(1963). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

This paper was abstracted from the original language and appeared as NSA 18: 16012. (M.C.G.)

16487 MODIFICATION AND UTILIZATION OF ISOTOPE FRACTIONATION PHENOMENA IN ANALYTICAL SEPARATIONS. Klein, Peter D.; Cejka, V.; Szczepanik, Patricia A. (Argonne National Lab., Ill.). Advan. Tracer Methodol. (U.S.), 4: 105-12(1968).

From 11th Symposium on Advances in Tracer Methodology, Boston. See CONF-661061-(Vol.4).

Isotopic fractionation effects in analytical systems are discussed. Isotope effects on amino acids were investigated to determine whether tritium substitution produced any significant effect and whether positional factors in ^{14}C and tritium labeling had any effect on the chromatographic mobility of these compounds. (M.C.G.)

16488 PERRHENATE ION AS A LIGAND IN COMPLEX COMPOUNDS. Bol'shakov, K. A.; Sinitsyn, N. M.; Travkin, V. F.; Borisov, V. V. (Inst. of Fine Chemical Industry, Moscow). Dokl. Akad. Nauk SSSR, 177: 344-6(Nov. 11, 1967). (In Russian).

In order to check the assumption that acid radicals such as ClO_4^- and ReO_4^- cannot form coordination compounds, the ability ReO_4^- to be coordinated by a central atom was investigated. The study included synthesis of a stable complex compound, $[UO_2(ReO_4)_2 \cdot 2TBPO]$, in which uranium acts as the center atom and the ReO_4^- radical as the acid ligand. The compound, bis-tri-n-butylphosphine oxide diperrhenate uranyl is insoluble in water and saturated hydrocarbons and soluble in benzene and oxygen-containing solvents. Thermogravimetric studies revealed that the compound possesses thermostability in air; it exhibits endothermic effect at 85 to 95°C due to melting, which was visually ascertained to occur within the 90 to 100°C range. The thermal decomposition starts at 360°C; a first exothermic effect at 380 to 395°C corresponds to the ignition of the organic portion of the compound, the second one at 405°C is caused by the removal of the perrhenate. In a polar solvent, methanol, the electrical conductivity changes from 6.7 to 13.6 $ohm^{-1} \cdot cm^2$ on increasing the dilution from 1:100 to 1:1000; this indicates a negligible dissociation. The coordination number of the central uranyl group of the trimeric molecule was found to be 6; at the ends of the group it might be 5 or 6. (TTT)

16489 VAPOR PRESSURES OF TRITIUM OXIDE AND DEUTERIUM OXIDE. INTERPRETATION OF THE ISOTOPE EFFECTS. Jones, Wesley M. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Chem. Phys., 48: 207-14(Jan. 1, 1968). (LA-DC-5905(Rev)).

Measurements are reported on the difference in vapor pressures of H_2O and T_2O (−9 to 114°C) and of H_2O and D_2O (4 to 114°C). The relative vapor pressures of the pure liquids are represented by $\ln(p_{H_2O}/p_{T_2O}) = (-103.87 \pm 0.57)/T + (46{,}480 \pm 210)/T^2$ and $\ln(p_{H_2O}/p_{D_2O}) = (-70.87 \pm 0.43)/T + (33{,}630 \pm 160)/T^2$. The normal boiling points of T_2O and D_2O are 101.51 and 101.42°C. Isotopic differences in heats of vaporization are given from 10 to 110°C. Triple-point temperatures and pressures are summarized. Vapor-pressure crossover temperatures are: D_2O-T_2O, 116.2 ± 0.5°C; H_2O-T_2O, 190 ± 10°C (estimated); H_2O-D_2O, 220.7 ± 0.1°C (literature). The data were also fitted to extensions of the above equations, which included correction terms based on Bigeleisen's formulation of the vapor-pressure isotope effect and a uniformist harmonic-oscillator model of water. Estimates of the coefficients of $1/T$ and $1/T^2$ for H_2O-D_2O from Raman spectra are in reasonable agreement with coefficients from this data fit. Ratios of corresponding coefficients for H_2O-D_2O and H_2O-T_2O agree with theory. (auth)

16490 MAGNETIC PROPERTIES OF UAs–USe SOLID SOLUTIONS. Trzebiatowski, W.; Misiuk, A.; Palewski, T. (Inst. of Low Temperature and Structure Research, Wroclaw. Technical Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 15: 543-7(1967).

The magnetic properties of UAs–USe solid solutions were investigated by the conventional Faraday method. Solid solutions containing 0 to 40 mole % USe remained antiferromagnetic with an approximately constant Néel temperature; but at 20 to 40 mole % of USe, the susceptibility became field-dependent at low temperatures. The 35 and 40 mole % USe samples showed intermediate properties because in addition to the antiferromagnetic transitions at 132 and 134°K, a ferromagnetic transition occurred at about 138 to 140°K. With USe-rich (≥45 mole %) samples, the Néel point disappeared and only ferromagnetic transitions were observed to occur with an increase in Curie temperature, which showed a flat maximum at about 80 mole % of USe. The Weiss constants changed in the same manner and so did the susceptibility at 290°K which attained a flat maximum at about 65 to 80 mole % USe, but the paramagnetic moments varied linearly with composition. (D.H.M.)

16491 KINETICS OF THE ISOTOPIC EXCHANGE OF IODINE IN MI_3-Et_2O-EtI LIQUID SYSTEMS (M = Al, Ga, In). Krzywanska, E.; Kaminski, A.; Polaczek, A. (Univ. of Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 15: 563-8(1967).

Results of kinetic studies on isotopic exchange in MI_3-Et_2O-EtI solutions (M = Al, Ga, and In and the metal iodide was labeled with ^{131}I) are reported and a mechanism is suggested. Kinetic curves for InI_3, GaI_3, and AlI_3 are given. The exchange rate constants were inversely proportional to the concentration of metal iodide and increased with temperature. The calculated energy of activation of the isotopic exchange reaction and the preexponential factor are given. Some conclusions regarding the $Et_2O \rightarrow MI_3$ bond strength were drawn from the kinetic data. (D.H.M.)

16492 LATTICE SPACING DETERMINATION FOR THE α AND β PHASES OF NICKEL–HYDROGEN AND NICKEL–DEUTERIUM SYSTEMS. Janko, A.; Pielaszek, J. (Inst. of Physical Chemistry, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 15: 569-72(1967).

The lattice constants of β-nickel hydride and β-nickel deuteride were determined. The calculated errors in the lattice spacing obtained were, in general, greater than those calculated earlier from the spread of readings. The calculated data showed that in the case of the β-Ni-H and β-Ni-D the nickel deuteride lattice spacing is smaller than the spacing in the hydride lattice. The results confirmed the existence of the α-Ni-H solutions and the β-nickel hydride previously postulated. The results appeared to confirm the dynamic coexistence of the α and β Ni-H phases as well as the α and β nickel deuteride phases with the lattice parameters: α-Ni-H, a = 3.5218 ± 0.0005 Å; α-Ni-D, a = 3.5219 ± 0.0004 Å; β-Ni-H, a = 3.7251 ± 0.0008 Å; and β-Ni-D, a = 3.7191 ± 0.0008 Å. (D.H.M.)

16493 METAL COMPLEXES WITH FLAVONS. PART II. STRUCTURE. Bilinska-Kozicka, Urszula (Univ. of Warsaw). Rocz. Chem., 41: 1479-82(1967). (In Polish).

The infrared spectra of beryllium, titanium(IV), and uranium(VI) complexes with rutin and quercetin were investigated. Results of these investigations enabled the determination of the structure of these complexes. (auth)

16494 SULFATE COMPLEX OF TRIVALENT URANIUM AND POTASSIUM. Peretrukhin, V. F.; Krot, N. N.; Gel'man, A. D. (Inst. of Physical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim., No. 11, 2586-7(Nov. 1967). (In Russian).

Analyses of complex compounds of trivalent uranium prepared from aqueous solutions showed that the pure anhydrous crystalline substance obtained, $K_5U(SO_4)_4$, does not contain uranium(IV) impurities. (R.V.J.)

16495 OXIDATION OF URANIUM–CARBON ALLOYS BY OXYGEN AT HIGH TEMPERATURES. Moreau, Claude; Philippot, Joseph (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. C, 266: 204-7(Jan. 15, 1968). (In French).

The evolution of heat that accompanies this reaction involves certain variations in the experimental results. One of these, the apparent variation in the coefficient of expansion as a function of the pressure, was used to calculate the high temperature that otherwise could not be measured with precision. (tr-auth)

16496 CENTRIFUGAL DISTORTION CONSTANTS IN $^{28}SiF_3H$ AND $^{28}SiF_3D$ MOLECULES. Rama Rao, C. G.; Santhamma, C. (Andra Univ., Waltair, India). Curr. Sci. (India), 37: 69(Feb. 5, 1968).

Three centrifugal distortion constants D_J, D_{JK}, and D_K for $^{28}SiF_3H$ and $^{28}SiF_3D$ were evaluated theoretically. Results agreed reasonably well with those previously reported. (J.G.B.)

16497 STUDY OF THE SYSTEM URANYL NITRATE–1-(2'-HYDROXYNAPHTHYLAZO)-2-NAPHTHOL-4-SULFONIC ACID–WATER. Spacu, P.; Mavrodin, Maria (Centre de Chimie Inorganique, Bucharest). Rev. Roum. Chim., 12: 1223-8(Oct. 1967). (In Rumanian).

The reaction between uranyl nitrate and 1-(2'-hydroxynaphthylazo)-2-naphthol-4-sulfonic acid-water was studied from the spectrophotometric point of view. The quantitative study of the system (carried out by the method of continuous variations, the point of constant absorption, molar ratio, and the slope of the extinction curves) indicated the formation of a compound characterized ratio of formation $UO_2^{2+} : R = 1 : 2$ (where R is the acid radical), a dissociation constant of 1.88×10^{-11}, and a molar extinction coefficient of 18,700. (tr-auth)

16498 STUDY OF THE PRECIPITATION OF AMMONIUM URANATES BEGINNING WITH SOLUTIONS OF URANYL NITRATE AND AMMONIA. Brusset, Henry; Dao, Nguyen Guy (Faculte des Sciences, Paris). Compt. Rend., Ser. C, 265: 1141-3(Nov. 20, 1967). (In French).

Potentiometric curves of the addition of ammonia to uranyl nitrate solutions show two equivalence points, whereas the conductimetric curve shows only the second equivalence point at 2.33 moles of ammonia. The existence of the first equivalence point at 1.67 moles of ammonia was interpreted by the formation of a metastable hexacondensed ion. The second equivalence point shows the end of the precipitation of the uranates beginning with the condensed ions of the solution. The infrared spectra of ammonium uranates has vibrations characteristic of the UO_2^{2+} and NH_4^+ groups. Chemical analysis confirmed these results, and showed that only the uranates obtained with a large excess of ammonia have a well-defined composition, with the formula $2UO_3 \cdot NH_3 \cdot 3H_2O$. (J.S.R.)

16499 THE ALKALINE HYDROLYSIS OF BENZAMIDE AND N-METHYL- AND N,N-DIMETHYLBENZAMIDE. Bunton, C. A.; Nayak, B.; O'Connor, Charmian (Univ. of California, Santa Barbara. Univ. Coll., London. Univ. of Auckland, N. Z.). J. Org. Chem., 33: 572-5(Feb. 1968).

The alkaline hydrolyses of benzamide and N-methylbenzamide, but not of N,N-dimethylbenzamide, were accompanied by extensive oxygen exchange between water and the amide. The values of k_e/k_h for benzamide decreased with increasing hydroxide ion concentration and were greater in deuterium than in protium oxide. For hydrolysis of benzamide, k_{H_2O}/k_{D_2O} was 1.4, and for N,N-dimethylbenzamide it was 0.88. These differences arose because of the solvent isotope effect on partitioning of the tetrahedral intermediate derived from benzamide. (auth)

16500 PREPARATION, CRYSTALLOGRAPHIC PROPERTIES, AND INFRARED SPECTRA OF QUADRIVALENT OXYHALIDES OF THORIUM, PROTACTINIUM, URANIUM, AND NEPTUNIUM. Bagnall, K. W.; Brown, D.; Easey, J. F. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., A, No. 2, 288(1968).

Actinide(IV) oxydihalides of the type MOX_2 (M = Th, Pa, U, and Np; X = Cl, Br, and I) were prepared by reaction of the appropriate tetrahalide with antimony sesquioxide, Sb_2O_3, at 400°C in a vacuum. Unit cell parameters are reported for the isostructural series of oxydichlorides that possess orthorhombic symmetry, space-group Pbam. Infrared spectra were recorded for all the compounds, and the results are compared with previous assignments for $UOCl_2$. Metal–oxygen vibrations occur in the region 600 to 225 cm^{-1}. (auth) (UK)

16501 THE INFRARED SPECTRUM OF CH_3SiHD_2. Wilde, R. E. (Texas Technological Coll., Lubbock). J. Mol. Spectrosc., 25: 291-311(Mar. 1968).

The infrared spectrum of CH_3SiHD_2 is reported for the 400 to 5000 cm^{-1} region. The fundamental frequencies are assigned to normal modes and correlated with the fundamental frequencies of CH_3SiD_3. Five bands were observed under high resolution in the 2000 to 5000 cm^{-1} region. Two of these bands at 2166.60 cm^{-1} and 4264.38 cm^{-1} were given a ground state A value of 1.321 ± 0.001 cm^{-1}. Upper state constants are reported for the 2166.60 cm^{-1} band. (auth)

16502 ABSORPTION SPECTRUM OF THE URANYL ION IN PERCHLORATE MEDIA. III. RESOLUTION OF THE ULTRAVIOLET BAND STRUCTURE; SOME CONCLUSIONS CONCERNING THE EXCITED STATE OF UO_2^{2+}. Bell, J. T.; Biggers, R. E. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Mol. Spectrosc., 25: 312-29(Mar. 1968). (ORNL-P-2915).

The ultraviolet spectrum of the aqueous uranyl ion in a perchlorate medium was resolved into twelve Gaussian shaped absorption bands. The visible and uv absorption spectra (1795 to 5000 Å; 55,710 to 20,000 cm^{-1}) of the uranyl ion, which under the experimental conditions is complexed only with water ligands, is composed of 24 detectable bands. A study of the relationships between the bands has led to a breakdown of the 24 bands into 7 major absorption bands (or band groups) which have an average spacing of 6137 cm^{-1}. A linear relationship between the band energies and the logarithms of the oscillator strengths of the 7 major bands was noted. The first two major bands are in agreement with two triplet excited states as previously proposed from theoretical considerations. The lower-lying, vibrationally perturbed triplet at 24 107 cm^{-1} is composed of 12 bands. The second triplet at 31 367 cm^{-1}, which is also vibrationally perturbed is composed of 7 bands. It is proposed that the 5 remaining very broad bands that show no vibrational structure represent electron transitions from the ground state to five excited states having regular energy increments. The fluorescence emission spectrum was shown to result from two excited levels to five vibrational levels in the ground state, but only 4.66% of the emitting energy was from the higher of the two excited levels. (auth)

16503 A STUDY OF THE CHEMISTRY OF REACTIONS OF POLYVALENT ELEMENT IONS WITH ORGANIC REAGENTS. COMMUNICATION 7. THE INTERACTION OF SCANDIUM WITH POLYHYDROXYFLAVONES. Nazarenko, V. A.; Antonovich, V. P. (Inst. of General and Inorganic Chemistry, Kiev). Zh. Anal. Khim., 22: 1812-17(Dec. 1967). (In Russian).

The interaction of scandium with three polyhydroxyflavones (quercetin, morin, and rutin) has been studied spectrophotometrically. It has been established that two types of complexes, fluorescent and nonfluorescent, are formed at different pH's of the solution. Three complexes are formed with quercetin of which two are fluorescent ones. Two complexes are formed with morin of which one complex is fluorescent. One nonfluorescent complex is formed with rutin. All the nonfluorescent complexes and one of the fluorescent quercetin complexes (pH 6.0 to 6.5) are electrically neutral. The other quercetin complex (pH 5.5 to 6.0) and the morin complex are positively charged. The ratio of the compounds in all the complexes is 1 : 1. A scandium ion substitutes one hydrogen atom in the reagent molecule. When fluorescent positively charged complexes with quercetin and morin are formed, the coordinating ions are $ScOH^{2+}$, during the formation of other complexes the coordinating ions are $Sc(OH)_2^+$. (auth)

16504 THERMODYNAMICS OF THE SYSTEM Ca–W–O. Vasil'eva, I. A.; Mudretsova, S. N.; Nikitina, S. D. Zh. Fiz. Khim., 42: 49-53(Jan. 1968). (In Russian).

The equilibrium reduction of $CaWO_4$ with hydrogen was investigated in the temperature interval from 950 to 1170°C. The reduction of $CaWO_4$ with hydrogen in this temperature interval occurs in three stages. The first stage $CaWO_4-CaWO_{3.90}$ appears with the region of homogeneity of $CaWO_4$, during which the region of homogeneity is expanded by increasing the temperature. The second stage is characterized by the formation of Ca_3WO_6 and W; the final products of the third stage of reduction are CaO and W. The temperature (959 ± 14°C) below which the compound $CaWO_6$ is unstable was determined. On the basis of experimental data obtained, the thermodynamic functions were calculated with evaluations of their precision for the compounds Ca_3WO_6 and $CaWO_4$ at 298°K. The thermodynamic functions at 298°K were calculated for $CaWO_4$. (tr-auth)

16505 SPECTROPHOTOMETRIC STUDY OF THE INTERACTION OF THORIUM WITH BROMOPYROGALLOL RED. **Vasilenko, V. D.; Shanya, M. V.; Bolbas, V. I. (Dnepropetrovsk State Univ., USSR). Zh. Anal. Khim., 22: 1818-22(Dec. 1967). (In Russian).**

The dissociation constant of the second stage for bromopyrogallol red has been found by a spectrophotometric method. It has been found that thorium ions form complexes with the reagent at the thorium and bromopyrogallol red ratios of 1 : 1 and 1 : 2 depending on the pH of the medium. The molar extinction coefficients and the stability of the thorium complexes formed have been established. (auth)

16506 ISOTOPIC EFFECT IN LIGHT SCATTERING BY CONCENTRATION FLUCTUATIONS. **Roshchina, G. P.; Antonova, M. G.; Ishchenko, E. D. (Kiev State Univ.). Ukr. Fiz. Zh., 12: 315-19(1967).**

The effects of intermolecular interaction and molecular weight on the development of concentration fluctuations are being investigated. Systems with separating phases were tested, as well as systems subjected to intensive concentration fluctuations without actually undergoing phase separation. The observed isotope effect in the concentration component of light scattering was fully consistent with published data concerning the variation of solubility with substitution of deuterioderivatives for one of the solution ingredients. Partial deuterization of one of the solution components increased the concentration scattering by 12 to 20% on the average. (M.C.G.)

16507 REDISTRIBUTION OF ISOTOPES IN OXYGEN–HYDROGEN REACTION IN A SILENT DISCHARGE. **Basov, Yu. G.; Semiokhin, I. A. (Moscow State Univ.). Zh. Fiz. Khim., 41: 2960-2(Nov. 1967). (In Russian).**

During hydrogen reactions with oxygen in a silent discharge ^{18}O was concentrated in the reaction products with the coefficient of separation equal to 0.93 ± 0.01. Deuterium remained in the residue of nonreacting gas with the coefficient of separation 1.20 ± 0.02. (tr-auth)

16508 LOW TEMPERATURE CUBIC AND TETRAGONAL ZIRCONIUM DIOXIDE MODIFICATIONS. **Polezhaev, Yu. M. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Fiz. Khim., 41: 2958-9(Nov. 1967). (In Russian).**

Stable modifications of ZrO_2 were observed at 1150°C (monoclinic), 1150 to 2300°C (tetragonal), and over 2300°C (cubic). However, thermal treatment of the unstable zirconium salts revealed the existence of low-temperature cubic and tetragonal modifications of zirconium dioxides that were formed due to the reduced crystal surface energy in the ZrO_2 crystals in the monocline → tetragonal → cubic series. (R.V.J.)

16509 DIFFUSION MECHANISM OF RARE EARTH ELUTION. **Maslova, G. B.; Nazarov, P. P.; Chmutov, K. V. (Moscow Inst. of Chemical Physics). Zh. Fiz. Khim., 41: 2985-7(Nov. 1967). (In Russian).**

Chromatographic elution of small quantities of rare earth elements by lactic and hydrochloric acids was determined by a mixed ion diffusion mechanism. Tabulated data are given on elution of cerium ($^{144}Ce \rightarrow {}^{144}Pr$) and ^{147}Pm on KU–2 × 8 resins. (R.V.J.)

16510 SOLVENT ISOTOPE EFFECTS ON CHEMICAL SHIFTS OF IONS IN AQUEOUS SOLUTIONS. **Loewenstein, A. (Inst. of Tech., Haifa, Israel); Shporer, M.; Lauterbur, P. C.; Ramirez, J. E. Chem. Commun., No. 4, 214-15(1968).**

Measurements of nuclear magnetic shieldings (chemical shifts) and nuclear spin relaxation times of ionic nuclei and solvent nuclei in aqueous solutions are said to contribute significantly to an understanding of ion–ion and ion–solvent interactions. It is reported that the isotopic composition of the solvent has marked effects on the shieldings of nuclei for a number of ions in aqueous solution. Some results are given for alkali halides. The isotopic shift for F^- in 0.5 $\underline{M}$ KF changed by <5% between 10 and 80°C, and varied linearly with D_2O/H_2O ratio. Concentration effects on the isotope shifts were also observed. It is suggested that the isotope shifts arise because the interactions between ions and their hydration spheres are altered by changes in molecular vibrational amplitudes caused by isotopic substitution. The problem of calculating isotope shifts is discussed. (UK)

16511 PURE ROTATION SPECTRUM OF DEUTERIUM FLUORIDE VAPOR. **Perkins, A. J. (Argonne National Lab., Ill.). Spectrochim. Acta, 24A: 285-6(Mar. 1968).**

The frequencies of fifteen lines observed in the pure rotational spectrum of DF vapor at room temperature are reported, and the resulting rotational constants of the ground vibrational state are compared with the corresponding values previously reported. (auth) (UK)

16512 KINETIC ISOTOPE EFFECT IN THE SULFONYLATION REACTION. **Kobayashi, M.; Honda, K.; Yamaguchi, A. (Tokyo Metropolitan Univ.). Tetrahedron Lett., 4: 487-90(Jan. 1968).**

Electrophilic aromatic substitution is generally regarded as proceeding in two steps through a σ-complex. Whether the second step, involving C–H bond rupture, is rate determining may be deduced by examining the hydrogen kinetic isotope effect. In some previous studies it was concluded that the proton removal step from the σ-complex is not the rate determining step for the sulfonylation reaction; this conclusion is based on the absence of a primary kinetic isotope effect. In sulfonylation reactions of some aromatic compounds employing an aluminium chloride–sulfonyl chloride complex in methylene chloride a primary isotope effect was found. Data are tabulated for the sulfonylation of benzene and benzene-d_6. Rate constants followed the third-order kinetic equation (first order for benzene, p-toluenesulfonyl chloride and aluminium chloride). Values for k_H/k_D were 2.44 at 0°C, 1.91 at 7°C, and 2.09 at 15.5°C. Energies and entropies of activation were also estimated. The reaction mechanism is indicated. Studies on the sulfonylation of bromobenzene also showed a primary hydrogen kinetic isotope effect (k_H/k_D = 1.77 at 0°C). (UK)

16513 SIMPLE AND MIXED URANYL CHELATES WITH α-PICOLINIC ACID AND 8-HYDROXYQUINOLINE DERIVATIVES. Eberle, S. H.; Robel, W. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Inorg. Nucl. Chem. Lett., 4: 113-17(Feb. 1968). (In German).

The preparation of U(VI) chelates of previously known "normal" and "solvated" types with α-picolinic acid, and also previously unknown mixed chelates containing both this acid and 8-hydroxyquinoline, is described. Thermal decomposition of these compounds was studied. Solubility curves were plotted and analyzed to determine the dissociation constant for the solvated simple chelate. (UK)

16514 HYDROLYSIS OF RARE EARTH CARBIDES. **Anderson, J. S.; Clark, N. J.; McColm, I. J. (Oxford Univ.). J. Inorg. Nucl. Chem., 105-11(Jan. 1968).**

The hydrolysis products of some rare earth carbides, oxycarbides, and nitride-carbides were studied. With hydrolysis under gentle conditions product distributions were simple and consistently reproducible, and were representative of the carbon species in the lattice. Consideration of the surface chemistry of the hydrolysis reaction was important in interpretation of results. The use of the hydrolysis reaction to study the nature of the carbon species in carbon-containing phases of several binary and ternary rare earth metal systems is outlined. (auth) (UK)

16515 CRYSTAL STRUCTURE OF SOME PROTACTINIUM BROMIDES. **Brown, D. (Atomic Energy Research Establishment, Harwell, Eng.); Petcher, T. J.; Smith, A. J. Nature (London), 217: 737-8(Feb. 24, 1968).**

The results reported indicate Pa coordination numbers of 6, 7, and 8. $PaBr_5$ was found to be dimorphic; β-$PaBr_5$, obtained by sublimation at 400 to 410°C in vacuo, crystallises in the monoclinic system (a = 8.385 Å, b = 11.205 Å, c = 8.950 Å, β = 91.1°, space group $P2_1/n$) and is virtually isostructural with UCl_5. The Br bridge, however, is symmetrical, whereas UCl_5 has an asymmetric Cl bridge. The bis-octahedral molecular unit is closely related to that of niobium and tantalum pentachlorides. The single-bond covalent radius of Pa(V) derived from the 6-coordinate β-$PaBr_5$ structure is 1.44 ± 0.02 Å. $PaOBr_3$ crystallised in the monoclinic system, with a = 16.911, b = 3.871, c = 9.334 Å, β = 113.67°, space group C2. It has a double chain structure, in which Pa is 7-coordinate. The chains are bound together by O and Br bridging, each O being coordinated to 3 Pa-atoms. This structure is markedly different from that of $NbOCl_3$. Full structural information is not available for $NbOBr_3$ or $TaOBr_3$, but infrared results suggest that the former has a type of oxygen bridge similar to that found for $NbOCl_3$. Data on stretching vibrations are given. $PaBr_4$ was found to be isostructural with $ThCl_4$, crystallising in the tetragonal system, with a = 8.824 Å, c = 7.957 Å, space group $I4_1$ amd. In this compound the Pa(IV) is coordinated by eight Br's in the form of a dodecahedron. (UK)

16516 SPECTRA OF URANYL COMPLEXES IN A DISTANT INFRARED REGION. Belyaev, Yu. I.; Vdovenko, V. M.; Ladygin, I. N.; Suglobov, D. N. Zh. Neorg. Khim., 12: 3222-4(Nov. 1967). (In Russian).

Uranium-ligand valence vibrations (ν_{U-L}) in the infrared spectra of some anionic uranyl complexes were investigated in the 75 to 190 cm^{-1} range, using a mercury lamp as the source and an optico-acoustical radiation detector with a quartz window. The spectra of $[UO_2Cl_3Br]^{2-}$ and $[UO_2Cl_3]^{2-}$ contained bands at 160 and 125 cm^{-1}; on the basis of theoretical considerations, these bands were attributed to the valency vibrations of U–Br and U–I. The estimated frequency for the vibration of U–Cl, 230 cm^{-1}, lies outside of the studied spectral range. The relatively weak and wide bands at 125 to 120.95 and 82 cm^{-1} in the spectra of $[UO_2Cl_4]^{2-}$, $[UO_2Cl_3Br]^{2-}$ and $[UO_2Cl_3I]^{2-}$ are due to deformation vibrations of the $[UO_2ClHal]^{2-}$ group; however, it is possible that the ligand–external cation vibrations also fall in this range. The calculated values agreed with earlier experimental data, thus indicating that the method proposed to estimate the band multiplicity factor in uranium compounds is correct. (TTT)

16517 DEUTERIUM ISOTOPIC SHIFTS IN THE SPECTRA OF URANYL SALTS. Pande, D. N. (Jodhpur Univ., India). Indian J. Pure Appl. Phys., 5: 339-42(Aug. 1967).

D_2O isotopic shift in the spectra of hydrated crystals of uranyl sulfates, uranyl chlorides, and uranyl perchlorate was studied at 90°K with a 1.5 m grating. The spectra of all the hydrates except uranyl chloride trihydrate showed a general violet shift of about 10 to 20 cm^{-1}. In addition to the general shift, some of the frequencies in the range roughly 100 to 390 cm^{-1} showed a somewhat larger shift, uranyl chloride trihydrate being again an exception. The general violet shift was interpreted as due to changes in the zero-point energies of the uranyl-water complex on deuteration and similarly the vibrational frequencies of about 100 and 250 to 390 cm^{-1} were attributed to the two different modes of vibrations of uranyl-water ligand bonds, on the basis of simple semi-empirical calculations. The absence of the shift in uranyl chloride trihydrate showed that water is not bound to the uranyl group strongly in all cases. (auth)

16518 HEAT CAPACITY OF DEUTERO-AMMONIUM BROMIDE FROM 17^0 TO 300^{0}K. Stephenson, C. C.; Karo, A. M. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 48: 104-8(Jan. 1, 1968).

The heat capacity of deutero-ammonium bromide was measured from 17 to 300°K. The heat-capacity curve is characterized by the appearance of two maxima. These are associated with polymorphic transitions in the crystal lattice and with the ordering of the ammonium ion tetrahedra with respect to the two equilibrium positions in the unit cell. The excess entropy associated with the maxima is in agreement with the order–disorder nature of the upper transition. A frequency of torsional oscillation for the ammonium ion in good agreement with infrared data is obtained from the Debye–Einstein function representing the heat capacity below 100°K. (auth)

16519 RAMAN SPECTRAL STUDIES OF HDO IN H_2O. Walrafen, G. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 48: 244-51(Jan. 1, 1968).

Argon ion laser- and mercury-excited photoelectric Raman spectra were obtained from a 6.2$\underline{M}$ solution of D_2O in H_2O in the temperature range from 16 to 97°C and at frequencies from 2000 to 3000 cm^{-1}. Examination of the OD stretching contours observed near 2500 to 2600 cm^{-1} revealed marked asymmetry, and a high-frequency shoulder was apparent in all cases. In addition, an isosbestic point was found at 2570 ± 5 cm^{-1}. The OD stretching contours were analyzed by means of a special-purpose analog computer, and two Gaussian components near 2510 to 2540 and 2630 to 2660 cm^{-1} provided adequate fits of the contours in the temperature range involved, although some indication of a third weak Gaussian Raman component was found, and three Gaussian components were employed to fit the infrared-absorbance contours also obtained in this work. The integrated Raman intensities of the two principal Gaussian components had opposite temperature dependences, and the component intensities yielded a value of 2.5 ± 0.6 kcal/mole for the van't Hoff ΔH^0 associated with the disruption of one O-D...O unit in good agreement with the O-H...O values of $2_{.8}$ kcal/mole obtained from previous Raman studies of water and 2.4 kcal/mole obtained by Worley and Klotz from near-infrared studies of HDO in D_2O. The presence of asymmetry in the form of a prounced high-frequency shoulder, and of an isosbestic point, constituted the principal experimental observations indicating that the OD stretching contours observed in the Raman spectra are composed of two or more components. The opposite temperature dependences of the integrated Raman intensities of the principal Gaussian components considered to comprise the OD stretching band, the resulting ΔH^0 value, and agreements between ΔH^0 values from various methods provide additional support for the two-state model of water structure. No evidence was obtained in support of the continuum model previously proposed. (auth)

16520 FAR-INFRARED ABSORPTION SPECTRA OF AQUEOUS SOLUTIONS OF STRONG ELECTROLYTES. Draegert, David A.; Williams, Dudley (Kansas State Univ., Manhattan). J. Chem. Phys., 48: 401-7(Jan. 1, 1968).

The infrared absorption of solutions of LiCl, KF, KCl, KBr, KI, NaCl, NaBr, NaI, $NaNO_3$, $NaClO_3$, $NaClO_4$, DCl, and NaOD in D_2O was studied in the spectral region 75 to 650 cm^{-1}; the absorption of HCl and NaOH solutions in H_2O in the region 75 to 1000 cm^{-1} was also investigated. Even for the highest concentrations, the solution spectra have a striking resemblance to the spectrum of the solvent. A broad, intense band attributable to the hindered rotation of water molecules and a much less intense band attributable to the hindered translation of water molecules appear in the spectrum of each solution. The frequencies, widths, and shapes of these bands are compared in some detail with the corresponding bands in the spectrum of pure water. Small but significant differences between the spectra of the solutions and the spectrum of water are noted. (auth)

16521 THERMODYNAMICS OF UCl_3 DISSOLVED IN MOLTEN ALKALI CHLORIDES. Hardy-Grena, C. (European Atomic Energy Community, Ispra, Italy). J. Nucl. Mater., 25: 337-9(1968).

The activity of UCl_3 in molten NaCl near its melting point was measured by means of its partial vapor pressure. It appears, from examination of the curves and results, that UCl_3 in solution in molten NaCl obeys Henry's law at concentrations below 1 mol % UCl_3. Above this value it presents a positive deviation from ideality, due probably to a self-association of UCl_3 in the melt. (M.C.G.)

16522 DIMETHYL SULPHOXIDE COMPLEXES OF THE ACTINIDE TETRACHLORIDES. Bagnall, K. W.; Brown, D.; Holah, D. H.; Lux, F. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., A, No. 2, 465(1968).

The actinide tetrachlorides form three series of complexes with dimethyl sulphoxide: (DMSO) MCl_4, 7DMSO (M = U, Np, and Pu), MCl_4, 5DMSO (M = Th to Np inclusive), and MCl_4, 3DMSO (M = Th to Pu inclusive). The preparation of the three series of complexes, and the stability trends within each series, are discussed, and some chemical and physical properties, and infrared spectra are reported. Unlike the other compounds the protactinium(IV) compounds are unstable at room temperature. By preparing two of the uranium tetrachloride complexes with $[^2H_6]$ dimethyl sulphoxide it was possible to make an unambiguous assignment of the S = 0 vibrational frequency. (auth) (UK)

16523 SOLUBILITY OF SILVER CHLORIDE IN DEUTERIUM OXIDE SOLUTIONS. Broadbank, R. W. C. (Leicester Coll. of Tech., Eng.); Dhabanandana, S.; Morcom, K. W. J. Chem. Soc., A, No. 2, 213(1968).

The solubility of silver chloride in dilute solutions of sodium chloride in deuterium oxide was measured at 25 and 45°C, using a radiochemical technique. The solubility products were evaluated at each temperature, together with other relevant thermodynamic data. The results suggest that the amount of undissociated silver chloride is smaller in D_2O than in H_2O. (auth) (UK)

16524 HYDROGEN ISOTOPE EXCHANGE IN SUBSTITUTED ANILINIUM IONS. Blackborrow, J. R.; Ridd, J. H. (University Coll., London). Chem. Commun., No. 3, 132-3(1967).

A study of the substituent effects of nitrogen poles in aromatic nitration was extended to hydrogen isotope exchange reactions. The exchange was followed from changes in peak areas in the PMR spectrum of anilinium ions in deuterosulphuric acid. Exchange rates were measured for a series of anisidinium and meta-xylidinium bisulphates, using several concentrations and a range of acidities of deuterosulphuric acid. It was concluded that the protonated substances react as such, and not through the corresponding free amines and that the positive pole exerts no obvious directing effect. (UK)

16525 SECONDARY HYDROGEN ISOTOPE EFFECTS IN THE NITRATION OF ANILINIUM IONS. Hartshorn, S. R.; Ridd, J. H. (University Coll., London). Chem. Commun., No. 3, 133-4(1967).

The slow rate of N-H isotopic exchange previously reported for the dimethylanilinium ion in concentrated deuterosulphuric acid also applies to the anilinium ion. The half-life for exchange of a 1 M solution of N,N,N-trideuteroanilinium bisulphate in 89% sulphuric acid is ~100 min and the rate decreases rapidly with acidity. Hence, at high acidities nitration of the anilinium ion can be made to occur much more rapidly than N-H exchange. The nitration of the anilinium ion and the N,N,N-trideuteroanilinium ion in both sulphuric and deuterosulphuric acids, and solvent isotope effects on the rate of nitration and the effect of replacing $-N^+H_3$ by $-N^+D_3$ were studied. Results are tabulated, and accord with earlier findings on the trimethylanilinium ion in that there is no significant solvent isotope effect on nitration rate; but there appears to be a significant change in the rate of reaction and in the product composition when the protonated pole is replaced by a deuterated pole. It was concluded that no one hydrogen of the $-N^+H_3$ group is singled out for a special role in the transition state. The difference between the rates of nitration and N-H isotope exchange also provides evidence that reaction through the equilibrium concentration of the free amine is not significant for nitration in strongly acid media. (UK)

16526 HYDROGEN ISOTOPE EFFECTS IN THE BROMINATION OF 1,3,5-TRIETHYLBENZENE, 2-BROMO-1,3,5-TRIETHYLBENZENE, AND 2,4-DIBROMO-1,3,5-TRIETHYLBENZENE. Nilsson, Ake (Univ. of Goteborg, Sweden. Chalmers Inst. of Tech., Goteborg, Sweden). Acta Chem. Scand., 21: 2423-9(1967).

Competitive experiments with partially deuterated material gave the isotope effects $k_D/k_H = 0.99 \pm 0.02$, $k_D/k_H = 0.80 \pm 0.04$ and $k_D/k_H = 0.60 \pm 0.03$ for the bromination of 1,3,5-triethylbenzene at −20°C, 2-bromo-1,3,5-triethylbenzene at 25°C, and 2,4-dibromo-1,3,5-triethylbenzene at 65°C, respectively, with molecular bromine in dimethylformamide. (auth) (Denmark)

16527 MASS SPECTROMETRIC EVIDENCE FOR THE GASEOUS URANIUM NITRIDE OXIDE MOLECULE. Gingerich, Karl A. (Battelle Memorial Inst., Columbus, Ohio). Naturwissenschaften, 54: 646(1967).

In the course of a mass-spectrometric study of the vaporization of a uranium nitride–uranium oxide mixture from a Knudsen cell, the NUO molecule was identified and its equilibrium concentration relative to other gaseous uranium-containing species and to N_2 determined. (M.C.G.)

16528 CHRONOPOTENTIOMETRIC STUDY OF THE REACTION Np(IV) + e → Np(III) IN FUSED EUTECTIC LiCl–KCl SOLVENT. Caligara, Franco; Martinot, Lucien; Duyckaerts, Georges (Univ., Liege, Belg.) J. Chim. Phys., 64: 1740-5(Nov.–Dec. 1967). (In French).

The reduction of the ion Np(IV) dissolved in LiCl–KCl eutectic was studied by chronopotentiometry in the temperature range 400 to 550°C. The reaction at the indicator electrode was Np(IV) + e → Np(III). It was found that the electrochemical reduction of Np(IV) is followed by a slow rearrangement of the shell of complexing Cl^- ions. The activation energy for the diffusion of Np(IV) decreased with increasing temperature. This phenomenon was interpreted on the basis of the hole theory. (auth)

16529 HYDROGEN ISOTOPE EFFECT AMONG THE DIFFERENT DEHYDRATION STAGES OF $CuSO_4.5\,H_2O$. Heinzinger, K.; Rao, T. S. (Max-Planck-Institut fuer Chemie, Mainz). Z. Naturforsch., 22A: 2111-12(Dec. 1967).

The D/H ratios liberated in the successive steps of dehydration of $CuSO_4 \cdot 5H_2O$ were compared. The D/H ratio in the two moles of water from the trihydrate was almost the same as that in the two moles from the pentahydrate. The water from the monohydrate was enriched in deuterium by 2.5%. (M.C.G.)

16530 PROTON SPIN RELAXATION IN PARAMAGNETIC ION SOLUTIONS: DEUTERIUM ISOTOPE EFFECT. Pollak, V. L.; Slater, R. R. (Oklahoma State Univ., Stillwater). Z. Naturforsch., 22A: 2110-11(Dec. 1967).

An attempt was made to account for changes in the rate of proton and deuteron spin relaxation with variations in the isotopic composition of the solution. (M.C.G.)

16531 LARGE ISOTOPE EFFECT OF CARBON IN THE ELECTROLYTIC DECOMPOSITION OF ORGANIC IONS. Thiemann, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 22A: 2116-17(Dec. 1967). (In German).

The decomposition of ^{14}C-labeled sodium formate and formic acid was investigated. Changes in ^{14}C specific activity during electrolysis were studied and effective isotope effects on the anode reaction found. (M.C.G.)

16532 INFRARED ABSORPTION BY HYDROGEN BONDS IN SINGLE CRYSTAL KH_2PO_4, KD_2PO_4, AND KH_2AsO_4. Hill, R. M.; Ichiki, S. K. (Lockheed Palo Alto Research Lab., Calif.). J. Chem. Phys., 48: 838-42(Jan. 15, 1968).

The infrared absorption spectrum of KH_2PO_4, KD_2PO_4, and KH_2AsO_4 single crystals was measured from 3000 to 1000 cm^{-1} over a temperature range from 20° to 300°K. Three broad absorptions were found at 2670, 2360, and 1720 cm^{-1} which are associated with the hydrogen bonds. The two upper frequencies were stronger for light polarized perpendicular to the polar axis but were also found for light polarized along the polar axis. These absorptions have counterparts in the deuterated crystal with a frequency ratio $\nu_H/\nu_D \simeq 1.35$. The lower-frequency absorption was strongest for light parallel to the polar axis and showed intensity changes at the Curie temperature, accompanying the appearance of a sharper absorption at 1850 cm^{-1} which had a Curie-law behavior above T_c. It was concluded that the uncoupled hydrogen-bond vibrations which gave rise to the absorption at 2670 and 2360 cm^{-1} showed no observable splitting of the ground or first vibrational state. This eliminated a double minimum potential with appreciable tunneling between minima as a model for this bond. In addition these motions appeared to make an angle of several degrees with the x, y plane of the crystal. The 1720-cm^{-1} absorption is a hydrogen-bond vibration primarily along the polar or z axis with the 1850-cm^{-1} line representing coupled motion along z among locally ordered bonds. (auth)

16533 REVISED THEORY FOR CALCULATING DISTRIBUTIONS OF PRODUCTS FROM THE CATALYTIC REACTION OF ETHYLENE WITH DEUTERIUM. Kemball, C. (Univ. of Edinburgh); Wells, P. B. J. Chem. Soc., A, No. 2, 444(1968).

A general theory was modified to make allowance for an isotope effect in the ethyl decomposition step. Values for the magnitude of the isotope effect were taken from the literature. Product distributions calculated using the revised theory are in better agreement with experiment than those obtained from the original theory. (auth) (UK)

16534 RECOMBINATION RATE OF DEUTERIUM ATOMS. Jacobs, T. A.; Giedt, R. R.; Cohen, Norman (Aerospace Corp., El Segundo, Calif.). J. Chem. Phys., 48: 947-8(Jan. 15, 1968).

The rate of D_2 decomposition behind shock waves was studied using DCl as the tracer. Recombination rate constants of 10^{18} T^{-1}, 1.75×10^{18} T^{-1}, and 2×10^{19} T^{-1} cc^2 $mole^{-2}$ sec^{-1} for Ar, D_2, and D, respectively, as collision partners. (M.C.G.)

16535 MICROWAVE SPECTRUM, STRUCTURE, BORON QUADRUPOLE COUPLING CONSTANTS, AND DIPOLE MOMENT OF DIFLUOROBORANE. Kasuya, T.; Lafferty, W. J.; Lide, D. R. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 48: 1-4(Jan. 1, 1968).

The microwave spectra of $H^{10}BF_2$, $H^{11}BF_2$, $D^{10}BF_2$, and $D^{11}BF_2$ were assigned. Rotational constants are 74 494.82, 10 496.74, and 9181.67 Mc/sec for $H^{11}BF_2$; 77 244.25, 10 495.35, and 9221.49 Mc/sec for $H^{10}BF_2$; 52 896.09, 10 498.29, and 8740.46 Mc/sec for $D^{11}BF_2$; and 54 081.82, 10 496.89, and 8771.57 Mc/sec for $D^{10}BF_2$. The structural parameters obtained from these constants and their estimated uncertainties are $r_{BH} = 1.311 \pm 0.005$ Å, $r_{BH} = 1.189 \pm .010$ Å, and $\angle FBF = 118.3° \pm 1°$. The quadrupole coupling constants were obtained. The dipole moment is 0.971 ± 0.010 D. (auth)

16536 THE pH FUNCTION OF GLASSES OF THE SYSTEM Li_2O–BaO–$(Pr,Nd)_2O_3$–SiO_2. Stepinac, M.; Karsulin, M. (Univ., Zagreb). Z. Anorg. Allg. Chem., 355: 219-24(Nov. 1967). (In German).

The pH-functions of glass electrodes of compositions such as Li_2O– BaO– SiO_2– UO_2 and Li_2O– BaO– SiO_2– $(Pr,Nd)_2O_3$ are described. Electrodes containing $(Pr,Nd)_2O_3$ and UO_2– $(Pr,Nd)_2O_3$ show the theoretical response with variation of pH and are free from any effect of asymmetry. Their electric resistance is extremely low. (auth)

16537 COMPLEXONS. XLII. INVESTIGATION OF THE 1:1 COMPLEX OF SOME TRI- AND TETRAVALENT METAL IONS WITH POLYAMINOCARBOXYLATES BY MEANS OF REDOX MEASUREMENTS. Bottari, E.; Anderegg, G. (Eidgenoessisches Technische Hochschule, Zurich). Helv. Chim. Acta, 50: 2349-56(Oct. 1967). (In German).

The formation of complexes of Ga^{3+}, In^{3+}, Bi^{3+}, Sc^{3+}, Zr^{4+}, and Th^{4+} with polyaminocarboxylate ions was investigated using potentiometric measurements with the redox couples Fe^{3+}/Fe^{2+} and Tl^{3+}/Tl^{+}. Some data concerning the formation of related hydroxo and hydrogen complexes are reported. (auth)

16538 CRYSTALLOGRAPHIC AND PARAMAGNETIC STUDY OF THE MIXED OXIDE $Ba_2(UFe)O_6$ CONTAINING U^{5+}. Dianoux, Albert-Jose; Poix, Paul (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. C, 266: 283-5(Jan. 22, 1968). (In French).

Crystallographic study of the mixed oxide Ba_2UFeO_6 permitted establishing that this molecule is an ordered perovskite with crystalline parameter 8.361 A and with the probable space group Fm3m. The study of the paramagnetism indicates that the uranium is in the +5 state. (tr-auth)

16539 INFLUENCE OF WATER VAPOR ON THE REACTION OF URANIUM WITH CARBON DIOXIDE AT HIGH TEMPERATURES. Paidassi, Jean; Desrues, Rene; Darras, Raymond (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., Ser. C, 266: 246-9(Jan. 22, 1968). (In French).

This influence of water vapor is particularly important at 400°C and below. Consequently, it must be attributed to the presence of the hydride, UH_3, as the basis of the films of uranium dioxide formed. (tr-auth)

16540 MAGNETIC SUSCEPTIBILITIES OF ALKALINE EARTH URANATES V AND VI. Brochu, R.; Lucas, J. (Faculte des Sciences, Rennes, France). Bull. Soc. Chim. Fr., No. 12, 4764-7(Dec. 1967). (In French).

Magnetic susceptibilities of alkaline earth uranates(V) and (VI) were measured from 85° to 300°K. The MU_2O_6 compounds (M = Ca, Sr, Ba) were paramâgnetic but did not follow exactly the Curie–Weiss law. This suggests the existence of a weak temperature-independent paramagnetism (T.I.P.) ascribed to the presence of UO_2^+ ions in these compounds. Effective magnetic moments (after correction of susceptibilities for diamagnetism and T.I.P.) are near the "spin only" value: $\mu_{eff} = 1.73$ B.M. The values of $\chi_{T.I.P.}$ obtained are in good agreement with those observed for uranates(VI), MUO_4 and MU_2O_7 (M = Mg, Ca, Sr, Ba) (about 150.10^{-6} c.g.s. ion/g uranium). (auth)

16541 REACTIONS OF PENTA- AND HEXAVALENT NEPTUNIUM AND PLUTONIUM WITH 8-HYDROXYQUINOLINE AND SOME OF ITS DERIVATIVES. Keller, C.; Eberle, S. H. (Technische Hochschule, Karlsruhe, Ger. Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). Radiochim. Acta, 8: 65-72(Nov. 1967). (In German).

Chelate compounds of pentavalent Np and Pu with 8-hydroxyquinoline having the formula $NpO_2(oxin) \times 2\ H_2O$ and $PuO_2(oxin)(Hoxin)_2 \cdot aq$, respectively, can be isolated from aqueous solutions by precipitation; the products are very pure. $NpO_2(oxin)$ is soluble in excess 8-hydroxyquinoline above pH 8 giving the anionic complex $[NpO_2(oxin)_2]^-$. This complex can be precipitated by adding tetraphenylarsonium ions; the salt prepared in this manner can be extracted into chloroform. The various oxinates of Np(V) have different absorption spectra so that the formation of these compounds can be followed easily. The stability constants of the chelate complexes of Np(V) and Pu(V) with 8-hydroxyquinoline (HOX), 8-hydroxyquinoline-5-sulfonic acid (H_2OXS), and 7-iodo-8-hydroxyquinoline-5-sulfonic acid (H_2IOS) were measured by photometric titration and ionic exchange, respectively, to (25°C, $\mu = 0.1$): system NpO_2^+/OX^-: $\log \beta_1 = 6.32$, $\log \beta_2 = 11.50$; system NpO_2^+/OXS^{2-}: $\log \beta_1 = 5.72$, $\log \beta_2 = 10.42$; system NpO_2^+/JOS^{2-}: $\log \beta_1 = 4.83$, $\log \beta_2 = 9.40$; system PuO_2^+/OXS^{2-}: $\log \beta_1 = 5.71$; and system PuO_2^+/JOS^{2-}: $\log \beta_1 = 5.08$, $\log \beta_2 \sim 9.1$. The values of enthalpy for the reaction between pentavalent Np and 8-hydroxyquinoline-5-sulfonic acid was calculated to: $-\Delta H = 10.6$ kcal/mole for the formation of the 1 : 1-complex, and $-\Delta H = 8.5$ kcal/mole for the formation of the 1 : 2-complex from the 1 : 1-complex. Chelates complexes of Np(VI) and Pu(VI) with 8-hydroxyquinoline could not be prepared. The hexavalent metal ions are rapidly reduced by the complexing agent at pH values necessary for the precipitation reactions of the hexavalent complexes. (auth)

16542 REFLECTION SPECTRA OF EUROPIUM(II), EUROPIUM(III), AND GADOLINIUM(III) OXIDES. Sinha, S. P. (Leeds Univ., Eng.). Indian J. Chem., 5: 451-2(Sept. 1967).

Reflection spectra of thin layers of pure oxides, viz. EuO, Eu_2O_3 and Gd_2O_3, have been recorded in the ultraviolet region, and the various peaks are briefly discussed. (auth)

16543 ISOMORPHISM OF THORIUM AND URANIUM(IV) TETRAACETATES. Eliseev, A. A.; Molodkin, A. K.; Ivanova, O. M. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim., 12: 2854-5(1967). (In Russian).

The structure of U and Th tetraacetates was studied with thorium acetate synthesized according to the following reaction: $Th(OH)_4 \cdot nH_2O + CH_3\ COOH \rightarrow \downarrow Th(CH_3COO)_4 + (n + 2)H_2O$. Experimental data established the isomorphism of $Th(CH_3COO)_4$ and $U(CH_3COO)_4$, and the coordination formula for thorium tetraacetate was found to be $[Th\mu\lambda-(CH_3COO)\mu-(CH_3COO)_3]$. The thorium coordination number in the tetraacetate is equal to 10. (R.V.J.)

16544 COORDINATED POLYMERIZATION OF URANYL FLUORIDE COMPLEXES WITH NEUTRAL LIGANDS IN ANHYDROUS SOLUTIONS. Vdovenko, V. M.; Skoblo, A. I.; Suglobov, D. N.; Shcherbakova, L. L.; Shcherbakov, V. A. Zh. Neorg. Khim., 12: 2863-5(1967). (In Russian).

Benzene solutions of uranyl fluoride complexes with tributylphosphine oxide (TBPO) and tributyl phosphate were studied using ir spectroscopy and nuclear magnetic resonance ^{19}F, in order to confirm the participation of fluorine ions in the coordinated polymerization and to determine the structure of uranyl fluoride with neutral ligands. Tabulated data of NMR and ir spectra of UO_2F_2 complexes with TBPO confirmed the hexamere structure of $[(UO_2)_6F_{12}(TBPO)_8]$ and the formation of coordinate polymers with fluorine-atom bridging in UO_2F_2–TBPO-benzene indicated that the fluorine link is a strong electron donor. (R.V.J.)

16545 URANYL NITRATE SOLVATION BY ETHYLENEBIS-[DIOCTYLPHOSPHINE OXIDE]. Gorlov, E. E.; Smirnov, V. F.; Zefirov, A. P.; Laskorin, B. N. Zh. Neorg. Khim., 12: 2866-7 (1967). (In Russian).

It was found that uranyl nitrate combined with ethylenebis [dioctylphosphine oxide] formed solvates with a ligand-metal ratio varying from 0.87 to 1.14, depending on the uranium concentration in the aqueous phase. (R.V.J.)

16546 POLAROGRAPHIC STUDY OF NIOBIUM(V) REDUCTION IN HYDROCHLORIC ACID-THIOCYANATE MEDIUM. Marchidan, Sofia; Facsko, Gh.; Dragulescu, C. (Research Center of Inorganic Chemistry, Bucharest). Rev. Roum. Chim., 12: 635-44(June 1967).

Niobium(V) formed a reducible complex in hydrochloric acid-thiocyanate medium. By adding acetone, well-developed reproducible waves were obtained. In order to establish the best reducing conditions, the influence of the reagents concentration and of the different factors, modifying the wave-height and the stability of the system were investigated. Therefore, for a content of 6$\underline{M}$ HCl, 0.6$\underline{M}$ NH_4SCN, and 20 percent acetone, a linear proportionality between the wave-height and niobium concentration (10^{-4} to $10^{-3}\underline{M}$) was obtained. In these conditions, the niobium(V) reduction wave was well-developed and reproducible, having $E_{1/2} = -0.462$ V (versus S.C.E.). The half-wave potential was independent of the niobium concentration but substantially varied concerning the medium acidity, the increasing of the acid concentration shifted $E_{1/2}$ to more negative values. The electrode process was diffusion controlled, and the plot of E versus $\log i/(i_d-i)$ indicated an irreversible reduction of niobium(V) for the one-electron reaction. (auth)

16547 POLAROGRAPHY OF URANIUM IN ACETATE MEDIUM IN THE PRESENCE OF HYDRAZINE. Athavale, V. T.; Dhaneshwar, R. G.; Padmanabha Iyer, C. S. (Bhabha Atomic Research Centre, Bombay). Indian J. Chem., 5: 424-6(Sept. 1967).

Uranium did not give a wave in hydrazine medium alone. Hydrazine, when used in conjunction with other supporting electrolytes, especially acetate buffer medium gave rise to increased diffusion current for uranium reduction. Hydrazine can be used also as a good maxima suppressor. Uranyl acetate formed up to 1 : 3 complexes. However, in the presence of hydrazine only 1 : 1 complex of uranyl acetate was obtained. The role of hydrazine in complex formation is discussed. (auth)

16548 EXCITATION OF THE URANYL ION BY INTRAMOLECULAR ENERGY TRANSFER. Kononenko, L. I.; Poluektov, N. S.; Burtnenko, L. M. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 321-3(Oct. 1967).

Translated from Opt. Spektrosk., 23: 598-601(Oct. 1967).

It is established that in triple complexes of uranyl ion with certain β-diketones and nitrogen-containing organic bases, excitation of the uranyl ion takes place by means of intramolecular energy transfer. The fluorescence intensity of uranyl in complexes with thenoyltrifluoroacetone and phenanthroline at 77°K and excitation by the mercury line at 365 nm was 2×10^4 times greater than the fluorescence intensity of an aqueous solution of uranyl nitrate at 293°K. (auth)

16549 FINE STRUCTURE OF THE LUMINESCENCE SPECTRA OF URANYL NITRATES. Volodko, L. V.; Komyak, A. I.; Sleptsov, L. E. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 319-21(Oct. 1967).

Translated from Opt. Spektrosk., 23: 593-7(Oct. 1967).

The luminescence spectra of crystals of uranyl nitrates complexed with mixed anions and cations were studied at 77°K. It was established that vibrations of the anions and cations appear in the luminescence spectra. (auth)

16550 CHARACTERIZATION OF DEFORMATION VIBRATIONS BY UNIT VECTORS NONPERPENDICULAR TO CHEMICAL BONDS. Prima, A. M. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 299-301(Oct. 1967).

Translated from Opt. Spektrosk., 23: 554-7(Oct. 1967).

A method of introducing vibrational coordinates characterizing deformation vibrations is used. The unit vectors determining the given coordinates are, in the general case, neither perpendicular to the bonds nor lie along the line connecting the centers of the atoms but have intermediate directions. On the basis of the calculation of force constants and frequencies of the H_2O molecule and its deuterated forms it is shown that a choice of coordinates is possible such that the nondiagonal force constants characterizing the interactions of bonds and valence angles vanish. There exists the possibility of evaluating the closeness of the molecular forces to the model of valence forces or to the model of central forces. (auth)

16551 CALCULATION OF THE ELECTROOPTICAL PARAMETERS AND ABSOLUTE INTENSITIES OF THE INFRARED BANDS OF DEUTEROSUBSTITUTED MONOGERMANES. Yarandina, V. N.; Sverdlov, L. M. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 337-8(Oct. 1967).

Translated from Opt. Spektrosk., 23: 626-8(Oct. 1967).

Calculations of the electrooptical parameters of monogermanes in first-order optical-valence theory, which characterize the polar properties of the Ge—H bands, were made and used to predict the absolute intensities of infrared bands of partially deuterated monogermanes. Results are tabulated for GeH_4, GeD_4, GeH_3D, $GeHD_3$, GeH_2D_2. (D.H.M.)

16552 POLAROGRAPHY OF ZIRCONIUM. Goswami, N. K.; Gaur, J. N. (Univ. of Rajasthan, Jaipur, India). Indian J. Chem., 5: 421-3(Sept. 1967).

Zirconium gave a well-defined diffusion-controlled wave in chloride, perchlorate, and nitrate supporting electrolytes. The reduction was irreversible and hence kinetic parameters have been calculated by Koutecky's method. The effects of adding acid and methylene blue to the solution were investigated and a mechanism of the reduction is proposed. The results are suggestive of a method for the quantitative determination of zirconium in the presence of other elements, viz., Mn^{2+} and Yb^{3+}, which are not influenced by methylene blue. (auth)

16553 HIGH TEMPERATURE OXIDATION KINETICS OF LANTHANUM METAL. Pethe, L. D.; Mathur, H. B.; Biswas, A. B. (National Chemical Lab., Poona). Indian J. Chem., 5: 427-9(Sept. 1967).

The kinetics of oxidation of the lanthanum metal has been studied in the temperature range 500 to 700°C at an oxygen pressure of 100 torr with the aid of a differential oil manometric system. The oxidation data at all temperatures can be described by a cubic rate law. It has been established that the obeying of the cubic rate law by the oxidation data is not due to the deviation from Wagner's diffusion controlled mechanism either as a result of aging of the oxide film or the delay in conversion of the lower oxide to the higher one. (auth)

16554 NEW COMPOUNDS OF LUTETIUM AND OF TERBIUM WITH SOME ORGANIC ACIDS. Spacu, P.; Plostinaru, Silvia (Centre de Chimie Inorganique, Bucharest). Rev. Roum. Chim., 12: 671-5(June 1967). (In French).

Some new compounds of lutetium and terbium were prepared with different organic acids: monobasic acids derived from benzoic acid (chloro- and bromomandelic acid) and dibasic acids (galactaric and adipic acids). The compounds synthesized were studied from the chemical point of view and, because of their properties, used to establish new methods for determination and separation. (tr-auth)

16555 HYDROGEN REACTIONS WITH GRAPHITE MATERIALS AT HIGH TEMPERATURES AND PRESSURES. Chi, J. W. H.; Landahl, C. E. (Westinghouse Electric Corp., Pittsburgh). Contract W-7405-eng-36. Nucl. Appl., 4: 159-69 (Mar. 1968). (LA-DC-8949).

The reaction kinetics of graphite with hydrogen at high temperatures and pressures was studied by measuring the rate of weight loss and surface recession of graphite samples. Under experimental conditions, methane and acetylene were the predominant products. From previous studies, surface reaction mechanisms were assumed to be rate-controlling, and first-order rate equations were postulated. The reaction rates were assumed to be proportional to the gross external surface area. Apparent reaction velocity constants were calculated from the data, and significant correlations, obtained by use of the Arrhenius equation, were verified by data reported in the literature. (auth)

16556 EXISTENCE, STRUCTURE, AND PROPERTIES OF RADON COMPOUNDS. Vasilescu, I. J. (Colorom Chemical Works, Codlea-Brasov, Rumania). Rev. Roum. Chim., 12: 835-8(July 1967).

The heats of formation of radon chloride and fluorides were estimated according to a method worked out by Pitzer. The following values were calculated: $\Delta H_{RnCl_2} = -7.6$ kcal/mole, $\Delta H_{RnF_2} = -75$ kcal/mole, and $\Delta H_{RnF_4} = -86$ kcal mole. The structure and some physico-chemical properties of these compounds and other potential radon compounds are discussed. (auth)

16557 MECHANISM OF $O(^3P)$ ADDITION TO CONDENSED FILMS. II. PROPENE, 1-BUTENE, AND THEIR MIXTURES. Klein, Ralph; Scheer, Milton D. (National Bureau of Standards, Washington, D. C.). J. Phys. Chem., 72: 616-22(Feb. 1968).

The kinetics of $O(^3P)$ addition to condensed films of propene and 1-butene was investigated at 90°K. The reaction rate was found to be independent of olefin concentration for both propene and 1-butene using propane as an inert diluent. Films containing mixtures of propene and 1-butene yielded mostly C_3 products at high olefin concentration and approached a limiting value of about 1.6 for the C_3/C_4 product ratio at infinite dilution in propane. When C_3D_6 films were used, the ratio of carbonyl to epoxide was measurably less than that obtained with C_3H_6. The results are interpreted in terms of a model that depicts the olefin film to be a nearly perfect sink for $O(^3P)$ atoms. The primary process is assumed to be the formation of a triplet adduct which undergoes either ring closure to form the epoxide or an intramolecular migration of a hydrogen atom to produce a carbonyl compound. The latter exhibits the expected isotope effect when D is substituted for H in the olefin reactant. The behavior of propene–1-butene mixtures can be accounted for qualitatively by assuming that propene not only reacts more rapidly but diffuses more easily than does the 1-butene. (auth)

16558 ISOTOPIC EXCHANGE BETWEEN p-NITROBENZYL CHLORIDE AND CHLORIDE IONS AS STUDIED BY ELECTRODEPOSITION. Beronius, P.; Johansson, H. (Univ. of Umea, Sweden). J. Phys. Chem., 72: 713-16(Feb. 1968).

An electrodeposition method for following the exchange of chlorine between organic and inorganic chlorides is described. It was used to study isotopic exchange between p-nitrobenzyl chloride and lithium radiochloride in anhydrous acetone over a temperature range from 15 to 35°C. The exchange was found to be of Sn2 type. A comparison was made with data for the same exchange reaction in aqueous acetone. (auth)

16559 FAR INFRA-RED SPECTRA OF SOME URANYL COMPLEXES. Hart, F. A.; Newbery, J. E. (Queen Mary Coll., London). J. Inorg. Nucl. Chem., 30: 318-19(Jan. 1968).

New or revised assignments in the region 500 to 200 cm^{-1} are suggested for the complexes $UO_2X_2L_2$ (L = Ph_3PO or Ph_3AsO; X = Cl, Br, NO_3, or NCS). The known compounds $Cs_2[UO_2Br_4]$, $Cs_2[UO_2Cl_4]$, and $Rb[UO_2(NO_3)_3]$ were also studied for comparative purposes. (UK)

16560 HANDBOOK OF THE PHYSICOCHEMICAL PROPERTIES OF THE ELEMENTS. Samsonov, G. V. (ed.). New York, IFI/Plenum Data Corporation, 1968. 952p.

Translation and updated revision of Fiziko-Khimicheskie Svoistva Elementov.

Data on the atomic structure and crystallochemical, thermochemical, thermodynamic, electrical, magnetic, electrochemical, mechanical, and nuclear properties of elements at room temperature and at high and low temperatures are given. Data on the chemical properties of elements and their toxic properties are also reported. (2598 references). (tr-auth)

16561 REACTIONS OF AMINE BORANES AND RELATED COMPOUNDS. I. MECHANISM OF DEHYDROGENATION OF DIMETHYLAMINE BORANE. II. SYNTHESIS OF TRIMETHYLAMINE CHLOROBORANES. Wiggins, James William. Gainesville, Fla., Univ. of Florida, 1966. 190p.

Thesis.

In order to determine the mechanism of the dehydrogenation of dimethylamine borane, $(CH_3)_2HNBH_3$, the following mixtures of compounds were heated for 24 hrs at 100°C: $(CH_3)_2DNBD_3$ and $(CH_3)_2HNBH_3$; $(CH_3)_2DNBH_3$ and $(CH_3)_2HNBD_3$ and these mixtures, $(CH_3)_2DNBH_3$ and $(CH_3)_2HNBH_3$; $(CH_3)_2HNBD_3$ and $(CH_3)_2-DNBD_3$; $(CH_3)_2HNBD_3$ and $(CH_3)_2HNBH_3$; $(CH_3)_2DNBH_3$ and $(CH_3)_2DNBD_3$ were heated for 1 hr at 100°C. The results indicated that the dehydrogenation reaction was bimolecular and that a kinetic isotope effect occurred during the reaction favoring the elimination of hydrogen rather than deuterium. The larger isotope effect when deuterium was substituted for hydrogen on the nitrogen atom than on the boron atom indicated the presence of a non-linear activated complex in which the NH bond was more stretched along the bond axis than was the BH bond. Trimethylamine chloroboranes were prepared by reacting trimethylamine borane, $(CH_3)_3NBH_3$, with mercuric chloride, hydrogen chloride, trimethylamine hydrochloride, antimony pentachloride, antimony trichloride, sulfuryl chloride, thionyl chloride, and trimethylamine trichloroborane, $(CH_3)_3NBCl_3$. The extent of chloro substitution on the borane was a function of the reagent used and the reaction conditions. Trimethylamine dichloroborane, $(CH_3)_3NBHCl_2$, was prepared and characterized. The reactions were all considered to be oxidation—reduction reactions in which the BH bond was the reducing agent. An order of reactivity of the oxidizing agents was determined to be: $SbCl_5 > SO_2Cl_2 > SOCl_2 > HgCl_2 > HCl > (CH_3)_3NHCl$. The reactivity of the BH bond decreased on chloro substitution of the boron atom in the order: $-BH_3 > -BH_2Cl > -BHCl_2$. This decrease in reducing ability of the BH bond was explained by an inductive effect in which the chlorine atoms withdrew electronic density from the boron atom, and thus from the BH bond. The model was consistent with the ^{11}B nuclear magnetic resonance spectra of the compounds. A mechanism was proposed in which the oxidizing agent accepted an electron pair from the hydridic BH bond. The mechanism proposed a non-linear activated complex which was analogous to the activated complex proposed for the hydrolysis of pyridine diphenylborane. The mechanism was consistent with all the experimental results. (Disser. Abstr.)

16562 X-RAY DIFFRACTION STUDIES OF NITRATE COMPLEXES OF THORIUM(IV) AND CERIUM(IV) IN SOLUTION. Larsen, Russell David Kent, Ohio, Kent State Univ., 1964. 143p.

Thesis.

Solutions of thorium(IV) nitrate and ammonium hexanitratocerate(IV) were investigated by the x-ray radial distribution method using the Waser–Schomaker formalism involving pair interactions. The thorium(IV) nitrate solutions were prepared in dilute nitric and perchloric acids and in pure water. The ammonium hexanitratocerate(IV) was a pure aqueous system. The radial distribution maxima for all of these solutions occur at radial distances of 1.3, 2.8 to 2.9, 3.6, 4.3, and 5.0 Å, and at other higher r values. There is no indication in these solutions of Th–Th or Ce–Ce bonding indicative of metal ion hydrolysis and polymerization, which were found in other studies at lower concentrations. The areas under the radial distribution peaks for the thorium(IV) nitrate solutions, when analyzed and interpreted in terms of pair interactions and the corresponding shape functions, all indicate an eight-coordinate structure of oxygen atoms separated by 2.8 Å from a central thorium(IV) ion. These interactions can be interpreted in terms of the average features of a distorted antiprism. It is proposed that two nitrate ions are coordinated as bidentate ligands to a central thorium(IV) ion with the remaining coordination positions being occupied by water molecules. Analysis of the aqueous ammonium hexanitratocerate(IV) solution shows the existence of the $Ce(NO_3)_6^{-2}$ species in solution. A coordination number of twelve for oxygens around a central cerium(IV) ion was found. It is proposed that the arrangement of nitrates around cerium(IV) ion approximates, on the average, an icosahedral shape. (Disser. Abstr.)

16563 REVERSIBILITY OF G-ACTIN-ADP POLYMERIZATION: PHYSICAL AND CHEMICAL CHARACTERIZATION. Grant, Robert John. New York, Columbia Univ., 1967. 89p.

Thesis.

The polymerization of G-actin–ADP is shown to be a reversible reaction: polymerization is favored by higher temperatures, depolymerization by lower temperatures. A series of G-actin–ADP = F'-actin equilibria were attained as a function of temperature, which allowed the computation of the following thermodynamic values: $\Delta H^0 = +33.8$ kcal/mole; $\Delta S^0 = +1.46$ eu; $\Delta G^0 = -8.5$ kcal/mole. These values show that the polymerization of G-actin–ADP is an entropy-driven reaction. Tetrabutylammonium ions raised the temperature of initiation of polymerization and correspondingly shifted the equilibrium toward the monomer side. Deuterium oxide, on the other hand, lowered the temperature of initiation of polymerization and so favored the polymer side of the equilibrium. Orthophosphate ions "locked" the F'-actin polymers so that lowering the temperature does not cause depolymerization. Tropomyosin and metin also prevented the temperature-induced depolymerization of F'-actin and their effects are maximal at the same ratios to actin, which probably exist in the muscle cell. A value for the intrinsic viscosity of G-actin–ADP was found, 0.036 dl/g, which is the expected value for a globular protein and which seems especially fitting for actin in view of the spherical units seen in the electron micrographs of F-actin. These low viscosity values were made possible by the development of a new method for the removal of tropomyosin from G-actin–ADP solutions. The increase in entropy accompanying the polymerization is discussed in terms of the release of bound water from the protein monomers during association. Ultracentrifugal analysis suggests that the depolymerization of an F'-actin polymer is an all-or-none phenomenon and gives promise of providing critical information on the modes of association and dissociation of actin polymers. (Disser. Abstr.)

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Refer also to abstracts 16470, 16641, 16683, 16786, 16992, 17150, 18043, and 18122.

16564 (COO-1617-10) HALOGEN ATOM REACTIONS ACTIVATED BY RADIATIVE NEUTRON CAPTURE AND ^{82m}Br AND ^{130m}I ISOMERIC TRANSITION. Progress Report No. 2, February 1967–February 1968. (Nebraska Univ., Lincoln. Dept. of Chemistry). Contract AT(11-1)-1617. 128p. Dep. CFSTI.

Reactions of bromine and iodine were studied in gaseous, liquid, and solid hydrocarbon systems and the polyhalomethanes. In all these reaction systems the hot atom was not initially bound to the target molecule. Facilities and instrumentation are described. Separate abstracts were prepared for 5 sections of the report. (M.C.G.)

For abstracts of individual sections see: 16565–16569.

16565 (COO-1617-10, pp 8-36) NATURE OF ISOMERIC-TRANSITION INDUCED ^{82}Br REACTIONS WITH CH_4 AND CD_4. Nicholas, J. B. (Nebraska Univ., Lincoln. Dept. of Chemistry).

The influence of rare gas moderators on the isomeric-transition-induced bromine reactions in CH_4 and CD_4 was studied. The relative importance of kinetic energy, positive charge, and electronic excitation energy of the recoil atom was determined. All irradiations were performed in the TRIGA Mark II reactor. ^{82}Br organic yields were determined by in-reactor and freeze-thaw techniques. Rare gases were inefficient in quenching excited species and because of their high ionization potentials they were very inefficient in undergoing charge transfer with $^{82m}Br^+$ ions. Only 3.7% of the ^{82}Br organic yield was sensitive to rare gas moderation. Data suggested the absence of an isotope effect between target molecules CH_4 and CD_4 in the process activated by isomeric transition of ^{82}Br; however, an isotope effect between the target molecules does exist for (n,γ)-activated bromine reactions. (M.C.G.)

16566 (COO-1617-10, pp 37-55) ISOTOPE EFFECTS OF IODINE REACTIONS ACTIVATED BY THE RADIATIVE NEUTRON CAPTURE AND ISOMERIC TRANSITION PROCESSES IN LIQUID HYDROCARBONS. Lambrecht, Richard M. (Nebraska Univ., Lincoln. Dept. of Chemistry). (COO-1617-8).

Possible isotope effects, especially between ^{128}I and (n,γ)-activated $^{130}I + {}^{130m}I$ in various liquid hydrocarbons, were investigated and the organic yields induced by $^{129}I(n,\gamma)^{130}I + {}^{129}I(n,\gamma)^{130m}I$, $^{127}I(n,\gamma)^{128}I$, and $^{130m}I(IT)^{130}I$ reactions were compared at several concentrations in selected hydrocarbons. Results are presented in tables. (M.C.G.)

16567 (COO-1617-10, pp 56-67) SUBSTITUENT EFFECTS IN ^{130}I REACTIONS ACTIVATED BY (n,γ) AND (IT) WITH VARIOUS POLYHALOMETHANES. Parks, N. J. (Nebraska Univ., Lincoln. Dept. of Chemistry). (TID-24257).

The effects of different substituents on the $^{129}I(n,\gamma)^{130}I + {}^{129}I(n,\gamma){}^{130m}I$ and $^{130m}I(IT)^{130}I$ induced organic yields and the radioiodine organic product distributions at several iodine concentrations in various liquid polyhalomethanes are reported. Where distributions of iodine products were produced by only isomeric transition events or by in-reactor irradiations the results were remarkably similar. (M.C.G.)

16568 (COO-1617-10, pp 68-105) ORGANIC YIELDS OF BROMINE AND IODINE INDUCED BY RADIATIVE NEUTRON CAPTURE AND ISOMERIC TRANSITION IN POLYCRYSTALLINE, N-HEXANE AND CYCLOHEXANE. Lambrecht, Richard M.; Ayres, Robert L. (Nebraska Univ., Lincoln. Dept. of Chemistry).

Organic yields of bromine in polycrystalline hexane induced by radiative neutron capture and isomeric transition were studied. It was concluded that organic yields may be a useful criteria for deducing the state of aggregation and complexing of bromine in organic matrices at 77°K. The ^{128}I and $^{130m}I + {}^{130}I$ yields in polycrystalline hexane and cyclohexane were also studied. All yields were extremely sensitive to trace impurities. (M.C.G.)

16569 (COO-1617-10, pp 106-21) RADIATIVE NEUTRON CAPTURE AND ISOMERIC TRANSITION ACTIVATED IODINE REACTIONS IN LIQUID AND SOLID BENZENE AT 77°K. Kemnitz, E. J. (Nebraska Univ., Lincoln. Dept. of Chemistry).

Reactions of recoil ^{130}I in liquid and solid benzene were studied. Data are presented in tables and graphs. (M.C.G.)

16570 RADIOLYSIS OF BINARY MIXTURES: A STUDY OF THE RADIATION CHEMISTRY OF METHANOL USING LABELED MOLECULES. Ekstrom, A.; Garnett, J. L. (Univ. of New South Wales, Sydney). Advan. Tracer Methodol. (U.S.), 4: 59-65(1968).

From 11th Symposium on Advances in Tracer Methodology, Boston. See CONF-661061–(Vol.4).

The presence of benzene during the radiolysis of methanol leads to typical protection curves for the yields of hydrogen and ethylene glycol. The yields of other products display a complex benzene concentration dependence, which may be interpreted in terms of various radical reactions involving benzene. Effects of deuterium showed the significance of radical scavenging processes as distinct from energy transfer in the elucidation of the protection mechanism. (M.C.G.)

16571 POSSIBLE INITIATION OF CIS-TRANS CONVERSION PROCESSES BY THE ACTION OF X RAYS. **Glikman, T. S.; Zabroda, O. V.; Zavgarodnyaya, L. N. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 177: 387-90(Nov. 11, 1967). (In Russian).**

The action of ultraviolet light and x rays on aqueous solutions of cinnamic acid, trans- and cis-4-stilbenecarboxylic acid, maleic acid, and the azo dye chrysophenine G, was examined in a parallel series of experiments in the concentration range from 10^{-3} to 10^{-4} mole/l. The concentration of isomers was determined spectrophotometrically, and in the case of maleic acid, by polarography, in argon atmosphere, under thermostated conditions. Exposure of cinnamic acid to either radiation resulted in the reduction of the sum of both isomers, indicating that the isomerization reaction was accompanied by the destruction of the compound. Similar results were obtained with the trans-4-stilbenecarboxylic acid and chryosphenine G. Exposure of maleic acid to x radiation resulted in a weak isomerization, but addition of an acceptor, cysteine, resulted in the formation of fumaric acid. It appears probable that exposure to ionizing radiation creates the conditions required for optical excitation of the dissolved material. (TTT)

16572 RADIOLYTIC OXIDATION OF ETHYLENE IN AQUEOUS SOLUTION. **Basson, R. A.; du Plessis, T. A. (Atomic Energy Board, Pretoria). Radiat. Res., 33: 183-93(1968).**

The nature and yields of the products of the radiolytic oxidation of aqueous ethylene have been determined as a function of the [ethylene]-to-[oxygen] ratio and of pH. At very low doses a chain mechanism is indicated, but at doses above 10^{17} eV/ml the data can be described in terms of nonchain reactions involving peroxy intermediates. Yields calculated from the proposed mechanism are in good agreement with the experimental data. (auth)

16573 GAMMA RADIOLYSIS OF ACETONITRILE. **Ayscough, P. B.; Drawe, H.; Kohler, P. (Univ. Leeds, Eng. Hahn-Meitner Inst. fuer Kernforschung, Berlin). Radiat. Res., 33: 263-73(1968).**

The γ radiolysis of acetonitrile has been studied at room temperature over a wide range of radiation dose and dose rate, and also in the presence of scavengers for radicals and for thermal electrons. The main product is a short-chain polymer (G = 4.2 molecules of CH_3CN per 100 eV of absorbed radiation). Other important products are hydrogen, methane, succinonitrile, and hydrogen cyanide, with smaller amounts of other hydrocarbons and nitriles. From the observed variation of product yields with dose and with scavenger concentration a mechanism is proposed in which the products of the primary ionization, CH_3CN^+ and e^-, are precursors of the radicals CH_2CN and CH_3, respectively, while recombination of ionic species produces "hot" H atoms. Observations of electron spin resonance spectra in the γ-irradiated solid at low temperatures are cited to support the proposed mechanism. (auth)

16574 REACTOR ORGANIC COOLANTS. III. TEMPERATURE, INTENSITY AND POSTIRRADIATION EFFECTS IN THE ELECTRON RADIOLYSIS OF META-TERPHENYL. **Wuschke, Donna; Tomlinson, M. (Atomic Energy of Canada Ltd., Pinawa). Nucl. Sci. Eng., 31: 521-30(1968).**

The radiation decomposition of meta-terphenyl by 1.35-MeV electrons was measured for temperatures from 200 to 440°C, beam currents from 3 to 100μA and average dose rates from 0.25 to 15 W/g. G(-terphenyl) was 0.25 at 300°C. Decomposition increased above 350°C and depended on the local radiation intensity rather than the average dose rate. At 440°C, G(-terphenyl) increased from 0.62 at 100-μA beam current to 1.6 at 3 μA. Decomposition increased with pulse frequency for intermittent irradiation. Postirradiation thermal decomposition was measured. Thermally initiated reactions did not contribute appreciably to decomposition during irradiation. The results indicate that above ≈350°C the radiolytic decomposition mechanism differs from that at lower temperatures. The data provide information about the contributions of radiolytic and pyrolytic decomposition in high-temperature organic-cooled nuclear reactor systems. (auth)

16575 RADIOLYSIS OF MULTIPHASE SYSTEMS: HYDROCARBONS-WATER-OXYGEN. II. RADIATIVE OXIDATION OF MIXTURES OF HYDROCARBONS AND THE EFFECT OF INHIBITORS. **Nowak, Zofia; Bryl-Sandelewska, Teresa; Kecki, Zbigniew; Minc, Stefan. Przem. Chem., 46: 736-40(Dec. 1967). (In Polish).**

Radiative oxidation of hexadecane with decalin, isooctane with decalin, dearomatized and deparaffinized petrol fraction, and two dearomatized diesel oils from Romashkino and Polish crude oils was carried out in an anhydrous form and in the presence of water. The hexadecane and decalin experiments were also carried out with additions that could influence the yield of oxidation products. Some products of radiative oxidation of hydrocarbon mixtures could inhibit the oxidation process. If the inhibitors formed in the radiation field or contained in the organic phase were water soluble, the process of oxidation in the presence of water was much more advantageous for oxidation products. (auth)

16576 MECHANISM OF FORMING HYDROCARBON CONTAMINATION ON SURFACES IRRADIATED WITH A NARROW ELECTRON BEAM. **Zhdanov, Gl. S.; Vertsner, V. N. Dokl. Akad. Nauk SSSR, 176: 1040-3(Oct. 11, 1967). (In Russian).**

It was shown that on decreasing the size of the electron beam to a few microns, the main source of contamination was the flow of hydrocarbon molecules by diffusion to the irradiated surface. The number of adsorbed molecules on the unirradiated part of the surface was greater than the number of adsorbed molecules under the electron beam. The presence of a concentration gradient led to a flow of molecules towards the irradiated surface. In calculating this flow it was assumed that the current density, j, and average migration velocity of the molecules, $\overline{v}$, did not depend on the distance, r, from the center of the beam. An expression was found for the number of molecules polymerizing per unit area in a unit of time. The rate of growth of the contamination layer was plotted as function R/ρ, where R is the beam radius and ρ is a characteristic length equal to 0.1 μ at a current density of about 0.1 amps/cm^2. (TTT)

16577 RADIATION AND PHOTOCHEMICALLY INDUCED TRITIUM SUBSTITUTION IN AROMATIC HYDROCARBONS. **Kroh, J.; Hankiewicz, E. (Technical Univ., Lodz, Poland). Chem. Phys. Lett., 1: 542-4(Jan. 1968).**

Benzene and toluene, saturated with tritiated water, were subjected to ^{60}Co γ radiation and uv light. The yields of H—H substitution were higher for benzene than for toluene. Naphthalene decreased the substitution yield for benzene. The excited molecule mechanism of substitution is discussed. (auth)

16578 EPR SPECTRA OF IRRADIATED FROZEN AQUEOUS SOLUTIONS. 9. PERCHLORIC AND PERCHLORATE "GLASSES" CONTAINING DIFFERENT ADDITIONS. **Khodzhaev, O. F.; Ershov, B. G.; Pikaev, A. K.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim., No. 1, 91-8(Jan. 1968). (In Russian).**

The EPR spectra of the γ-irradiated glassy aqueous solutions of $HClO_4$ (5$\underline{M}$) and $NaClO_4$ (10$\underline{M}$) in the presence of different impurities (HCOOH, NO_3^-, NO_2^-, CH_3OH, etc.) were investigated at −196°. In the systems investigated the corresponding free radicals were identified and their yields were measured. The dependence of $G(H_2)$ on the HCOOH concentration in 5$\underline{M}$ $HClO_4$ solution was investigated. An increase of the concentration of radicals, recorded by the EPR method, after heating to −140°, of solutions of $HClO_4$ and $NaClO_4$ containing HCOOH, aldehydes, NO_3^-, NO_2^-, CH_3OH, or H_2O_2 was observed. The solutions were γ irradiated at −196°. It was found that this effect is most probably caused by ClO_4 radicals. (tr-auth)

16579 RADIOLYSIS OF TYROSINE AQUEOUS SOLUTIONS. **Brodskaya, G. A.; Sharpatyi, V. A. (Inst. of Nuclear Physics, Tashkent). Zh. Fiz. Khim., 41: 2850-4(Nov. 1967). (In Russian).**

Analysis of tyrosine transformation in irradiated aqueous solutions and the influence of the pH of the medium on the course of the process indicated that tyrosine oxidation with OH and HO_2 radicals was the main process during irradiation. The pH influenced, considerably, the qualitative and quantitative product obtained by radiolysis. (R.V.J.)

16580 EFFECT OF γ RADIATION ON THE CATALYST OF THE HYDROCHLORINATION REACTION OF ACETYLENE. **Dzhagatspanyan, R. V.; Taber, A. M.; Sokolov, V. A.; Treger, Yu. A. Zh. Fiz. Khim., 42: 263(Jan. 1968). (In Russian).**

The effect of γ radiation from ^{60}Co on catalysis of the hydrochlorination of acetylene was investigated. The sublimation of $HgCl_2$ with surface catalyst was produced under the effects of γ radiation. (tr-auth)

16581 ELECTRIC CONDUCTIVITY OF LEAD AZIDE CONTAINING Cu^{2+} AND Ag^+ AZIDES. **Zakharov, Yu. A.; Savel'ev, G. G.; Shechkov, G. T. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 10: 1191-4(1967). (In Russian).**

Coprecipitation of lead azide with silver azide and copper azide resulted in increased ion and photoconductivity of PbN_3 in the first case and in reduced conductivity in the second case, respectively. Analysis of the electrophysical properties of precipitated azides suggested the formation of a diffused solid solution in PbN_6—CuN_6, while formation of the solid solution in PbN_6—AgN_3 was not found. The admixture of Ag^+ ions in PbN_6 increased the rate for azide radiolysis while Cu^+ ions slowed it down. (R.V.J)

16582 RADIATION CHEMISTRY OF OXYCHLORIDE COMPOUNDS. VIII. INVESTIGATION OF THE RADIOLYSIS MECHANISM OF FROZEN SOLUTIONS OF SODIUM PERCHLORATE BY EPR METHODS. Belevskii, V. N.; Bugaenko, L. T. Zh. Fiz. Khim., 42: 105-12(Jan. 1968). (In Russian).

In neutral solutions of $NaClO_4$, irradiated with γ radiation at −196°C, the radicals H, OH, O^-, and O_2^- and stabilized electrons were formed. During heating the radicals H, OH, and e_{st} disappeared and ClO_2 and additional quantities of O^- and O_2^- appeared. In acid solutions of $NaClO_4$ the radicals H, OH, HO_2, ClO_2, and ClO_3 were detected in the EPR spectrum. The yields of these radicals appear to be complex functions of the acidity of the medium. A mechanism was proposed for the formation and for the reaction of free radicals in the frozen acid and neutral solutions of $NaClO_4$. (tr-auth)

16583 RADIOCHEMISTRY OF ClO COMPOUNDS. VII. AQUEOUS SOLUTIONS OF ClO_2. Bugaenko, L. T.; Roshchektaev, B. M. (Moscow State Univ.). Zh. Fiz. Khim., 41: 2844-9(Nov. 1967). (In Russian).

Experiments with radiochemical transformation of ClO_2 in dilute aqueous solutions at room temperature showed that chlorite and chlorate ions are the main products of the x-irradiation of chlorine dioxide. The mechanism of the radiochemical transformation of ClO_2 is described and the ratio of the constant $k_{O_2^- + ClO_2}/k_{O_2 + O_2^-}$ was found to be 1.7 ± 0.6. (R.V.J.)

16584 MECHANISM OF MUCONIC DIALDEHYDE FORMATION DURING RADIOLYSIS OF BENZENE AQUEOUS SOLUTIONS CONTAINING OXYGEN. Kartasheva, L. I.; Pikaev, A. K. (Moscow Inst. of Physical Chemistry). Zh. Fiz. Khim., 41: 2855-8(Nov. 1967). (In Russian).

The yields obtained by gamma radiolysis of aqueous benzene solutions containing oxygen did not indicate a dependence on the dose in the range 2×10^{14} to 2×10^{23} eV/ml sec. These yields were phenol, muconic dialdehyde (2,4-hexadienedial), and hydrogen peroxide. It was postulated that phenol and muconic dialdehyde were formed in neutral media as a result of monomolecular disintegration of the $O_2C_6H_6OH$. (R.V.J.)

16585 MECHANISMS OF THE RADIATION-CHEMICAL HYDROXYLATION OF 4-NITROPHENOL IN AQUEOUS SOLUTIONS. II. DEHYDRIDATION OF INTERMEDIATE SUBSTITUTED CYCLOHEXADIENYL RADICALS. Volkert, O.; Termens, G.; Schulte-Frohlinde, D. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys. Chem. (Frankfurt), 56: 261-7 (Dec. 1967). (In German).

G-values for nitrogen and for 2-hydroxy-4-nitrophenol, as well as G-values for 4-aminophenol were measured in the presence of N_2O as a function of 4-nitrophenol concentration. From these data it could be concluded that the intermediately formed cyclohexadienyl radical is not dehydridated by an excess of 4-nitrophenol by its reduction products. Charge transfer by N_2O^- radical anions of 4-nitrophenol were not found in the concentration region investigated. (tr-auth)

16586 HYDROGEN YIELDS IN THE RADIOLYSIS OF HYDROCARBON MIXTURES. Bergdolt, A.; Schulte-Frohlinde, D. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys. Chem. (Frankfurt), 56: 254-60(Dec. 1967). (In German).

The G-values of hydrogen formation in mixtures of cyclohexane with 2,2,4-trimethylpentane with and without additions of 2% naphthalene and 2.5 and 10% l-hexanethiol. The $G(H_2)$ values were not a linear function of composition. A linear relation was achieved by the addition of naphthalene for the lowering of the $G(H_2)$-values or by the addition of l-hexanethiol for the raising of $G(H_2)$-values. The results are explained by charge transfer between components of the mixture. (tr-auth)

16587 PROTECTING EFFECT OF SOME ORGANOPHOSPHORUS COMPOUNDS IN THE RADIATION DEGRADATION OF POLYMETHYLMETHACRYLATE. Kondrat'eva, L. V.; Kotov, B. V.; Gefter, E. L.; Serenkov, V. I. Vysokomol. Soedin., Ser. B, 9: 751-5(Oct. 1967). (In Russian).

The structure of the organophosphorus compounds affects their protective properties to a significant degree. Phosphites protect poly(methyl methacrylate) to a greater degree than phosphates; triphenylphosphine has a slight protective effect. During irradiation of films of poly(methyl methacrylate) containing triphenylphosphine, the formation of the cation radical triphenylphosphine occurred and during the irradiation of films containing triphenyl phosphite the phenoxy radical is probably formed. The degree and probable mechanism for the protective effect was determined by the structure of the organophosphorus additions. (tr-auth)

16588 THE ROLE OF OXYGEN CARRIERS IN THE CHEMICAL CONSEQUENCES OF NUCLEAR RECOIL IN HEXAMMINO Co(III) NITRATE. Venkateswarlu, K. S.; Kiskore, K. (Bhabha Atomic Research Center, Trombay, India). J. Inorg. Nucl. Chem., 30: 320-2(Jan. 1968).

Hexamminocobalt(III) nitrate was irradiated with neutrons at 40°C at a neutron flux of 1×10^{11} n/cm²/sec and a gamma dose of about ~1 Mrad/hr. The recoil products of reactor-irradiated hexamminocobalt(III), which migrated to different distances during an electrophoresis run, were identified by comparison with the migration of the corresponding pure labeled compounds. The percentages of ^{60}Co found in the form of different species after reactor irradiation as well as after subsequent thermal annealing were calculated from the counting data. In order to explain the differences in the behavior of annealing of ^{60}Co to nitropentamminocobalt(III) and hexamminocobalt(III), a mechanism involving oxygen carriers appears to be more reasonable. (P.C.H.)

16589 RADIATION STABILITY OF SOLID INORGANIC SALTS. Zakharov, Yu. A.; Vorob'ev, A. A.; Nevostruev, V. A.; Serikov, L. V. (Tomsk Polytechnic Inst., USSR). Zh. Fiz. Khim., 41: 2861-4(Nov. 1967). (In Russian).

Radiochemical yields (G_0) of products of radiolysis with 1.6 MeV electrons of inorganic salts (chlorates, bromates, iodates, and nitrates of alkaline earths and alkali metals) were evaluated as a function of their chemical composition. The variations in G_0 in identical type salts were studied considering the rate of competing direct and indirect (annealed) reactions at temperatures ranging from 125 to 300°K. (R.V.J.)

16590 KINETICS OF ISOTOPIC EXCHANGE BETWEEN DEUTERIUM AND $\gamma-Al_2O_3$ HYDROXYL GROUPS IN γ RADIATION FIELD. Dolidze, G. M.; Kolbanovskii, Yu. A.; Polak, L. S.; Tsagareli, R. V. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 58: 305-10(Nov. 1967). (In Russian).

Previous investigations of the kinetics of isotopic exchange of deuterium with silica gel hydroxyl groups in a mixed (n,γ) field in a reactor gave an expression $-dn/dt = k_1\sqrt{n}(S\beta - n_0 + n) - k_2(n_0 - n)^{\frac{1}{2}}$, (where n is the number of deuterium atoms flowing in the gas phase, n_0 is the initial number of deuterium atoms, S is the specimen surface area in cm², β is the number of hydroxyl groups exchanging per unit of the surface; and, k, and k_2 are the constants, including the product of the rate of the direct and inverse reaction per dose). An attempt was made to verify the applicability of the equation in studies of another solid ($\gamma-Al_2O_3$) and another radiation (^{60}Co γ radiation at 20°C), as well as the effects of the dose and temperature of the preliminary thermovacuum treatment on the kinetics of the process. (R.V.J.)

16591 ENRICHMENT OF ^{32}P BY ACTIVATION OF TRIPOLYPHOSPHATE. Matsuura, Niro (Tokyo Univ.); Kurimura, Yoshimi; Shinohara, Nobuyoshi. J. Nucl. Sci. Technol. (Tokyo), 4: 595-600(Dec. 1967).

Enrichment of ^{32}P was attempted by the Szilard–Chalmers effect on a neutron-irradiated tripolyphosphate hexahydrate in the first eluate from an anion-exchange resin column by chromatographic separation with gradient elution. Forty to fifty % of the ^{32}P was found as orthophosphate, having a specific activity of around 100 mCi/g of phosphorus at the end of about 20 min irradiation with a neutron flux of 5×10^{12} n/cm²·sec in the KUR 1-MW reactor. The increase of specific activity is straightforward for a short period of irradiation. The enrichment factor was several thousand when recrystallized tripolyphosphate hexahydrate was used as target compound containing 0.02% of orthophosphate-P as impurity. Radiation effects, radiolysis by γ rays and fast neutron, thermal degradation and isotopic exchange were examined as factors that might affect the enrichment. The relation between the specific activity of the isolated phosphates and the exposure time was established from a series of experiments in which the time of irradiation was varied. (auth)

16592 YIELD OF SOLVATED ELECTRONS IN THE γ RADIOLYSIS OF WATER + 10% ETHANOL: NONHOMOGENEOUS KINETICS OF ELECTRON SCAVENGING IN WATER. Russell, J. C.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Chem. Phys., 48: 90-4(Jan. 1, 1968).

The effect of nitrous oxide concentration over a very wide range, and at low dose, on the radiolysis of the system water + 10% ethanol was investigated. At very high concentrations $G(N_2) = 4.0$, compared to approximately 2.7 between 10^{-4} and $10^{-2}\underline{M}$ nitrous oxide. The results are discussed in terms of a nonhomogeneous kinetics model for the scavenging of solvated electrons, with G(total ionization) = 4.0. The free ion yield is $G(e^-_{solv})_{fi} = 2.7$. These values apply to both the present system and to pure water. The wide variation in previously reported values of $G(e^-_{aq})$ is understandable in terms of the present model. The previously published model for charge scavenging in liquids [J. Chem. Phys.

46: 2822 (1967)] was moderately successful in describing charge scavenging in the γ radiolysis of hydrocarbons, alcohols, and water. This emphasizes the earlier suggestion that the behavior of extra electrons in nonpolar and polar liquids differs in degree but not in kind. (auth)

16593 THERMOLUMINESCENCE AND PHASE TRANSITIONS IN INORGANIC COMPOUNDS. **Bettinali, C.; Ferraresso, G. (Univ., Rome). J. Chem. Phys., 48: 517-8(Jan. 1, 1968).**

Inorganic compounds, having known transition points in the range 80 to 500°K, were studied to see whether after x-irradiation, thermoluminescent peaks occurred during phase transitions. All solid compounds studied showed thermoluminescent maxima before and after their transitions points; among the phosphates of the type MeH_2PO_4, which show glow curves having the corresponding glow maxima at the same temperature, only KH_2PO_4 showed a thermoluminescent peak in coincidence with the transition point; ammonium sulfate and sulfur presented glow curves having a thermoluminescent minimum that coincided with the transition-point temperature; and when a solid-liquid transition occurred, there arose a thermoluminescent intensity breakdown coincident with the phase-transition temperature. It was concluded that the relationship between thermoluminescent peaks and phase transitions, as found in organic substances, is not valid for the examined inorganic compounds. (D.H.M.)

16594 ENERGY TRANSFER IN ORGANIC SOLIDS. **Rosenstock, Herbert B. (Naval Research Lab., Washington, D. C.). J. Chem. Phys., 48: 532-3(Jan. 1, 1968).**

The photoluminescence of irradiated anthracene was used to study energy transfer processes in organic crystals. One mechanism considered for energy transfer in a lattice is a random walk to nearest neighbors. (M.C.G.)

16595 IRRADIATION OF DIHYDROPYRIMIDINES. **Snipes, Wallace; Bernhard, William (Pennsylvania State Univ., University Park). Contract AT(30-1)-3799. Radiat. Res., 33: 162-73(1968). (NYO-3799-3).**

The conversion of dihydrouracil to uracil, dihydrothymine to thymine, and dihydro-6-methyluracil to 6-methyluracil by gamma irradiation both in aqueous solution and in the solid state was studied. In aqueous media, G values for the conversion process in dihydropyrimidine solutions (1 mg/ml) bubbled with oxygen, nitrous oxide, and nitrogen were 2.55, 2.27, and 0.73, respectively, for uracil; 2.17, 1.78, and 0.41 for thymine; and 2.40, 2.25, and 1.43 for 6-methyluracil. In the solid state, G values for uracil, thymine, and 6-methyl uracil were 1.0, 0.9, and 0.9, respectively. The effect of dihydrouracil concentration on the G value for uracil production in oxygenated aqueous solution was measured. Free radicals formed in polycrystalline dihydrothymine and dihydro-6-methyluracil were studied by ESR spectroscopy. Dose-response relationships for radical production and destruction by the radiation were measured. The G values for radical production in dihydrothymine and dihydro-6-methyluracil were found to be 0.85 and 0.45, respectively. The close correspondence between the G values for radical production in these dihydropyrimidines and the G values for their conversion to unsaturated compounds in the solid state suggests the possibility that the radicals are intermediates in this process. (auth)

16596 EFFECT OF INDUCED RADIOACTIVITY ON THE DISSOLUTION AND HYDROGEN PRODUCTION OF ARMCO IRON IN MINERAL ACID SOLUTIONS. **Spitsyn, Vikt. I.; Laptev, N. Ya.; Balezin, S. A. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 174: 143-6(May 1, 1967). (In Russian).**

Disk samples of Armco iron, irradiated at a neutron flux of 1.2×10^{13} neutrons cm^{-2} sec^{-1} to give induced ^{59}Fe activities of 1.5, 3.0, 4.3, and 5.4 mCi/g, were exposed to HCl, H_2SO_4, and $HClO_4$ solutions. The induced radioactivity tended to slow down the dissolution of the irradiated sample as compared to the unirradiated sample. On increasing the specific activity up to 3 mCi/g in 5 $\underline{N}$ H_2SO_4, the dissolution of iron was noticeably slowed down with increasing specific activity. A significant decrease in dissolution rate of the iron in 5 $\underline{N}$ $HClO_4$ was observed with radioactive Armco iron (0.5 mCi/g) as compared to unirradiated Armco iron (0.008 compared to 0.012 g dm^{-2} hr^{-1} for the unirradiated sample). This difference in behavior is attributed to the presence of a positive charge on the anode film of the passivating oxide layer. Electrochemical measurements in 1 $\underline{N}$ H_2SO_4 at 20°C showed a hydrogen overvoltage on radioactive iron having a specific activity of 4.5 mCi/g, which was 18 to 20 millivolts higher than on the unirradiated sample. Behavior in HCl solution was different, since the corrosion products did not accumulate on the metal surface in this case. (TTT)

16597 OXIDATION OF METHYL OLEATE INDUCED BY ^{60}Co γ-RADIATION. PART 2. EMULSIONS OF METHYL OLEATE IN WATER. **Hyde, S. M.; Verdin, D. (United Kingdom Atomic Energy Authority, Wantage, Eng.). Trans. Faraday Soc., 64: 155-62(Jan. 1968).**

The kinetics of the ^{60}Co γ-induced oxidation of emulsions of methyl oleate in water, stabilized by sodium oleate, were studied at 30°C. Emulsification increases the rate of oxidation by factors up to 5.8 under the conditions employed. At dose rates below 9.8×10^{17} eV $l.^{-1}$ sec^{-1} the rate of oxygen absorption was proportional to the square root of the dose rate, and increased with the ratio of water to methyl oleate and with the concentration of the emulsifying agent. The effect of an oil-soluble inhibitor indicated that the acceleration of the oxidation arises entirely from an increase in the initiation rate, and that the propagation and termination reactions take place in the emulsion droplets. (auth) (UK)

16598 OXIDATION OF METHYL OLEATE INDUCED BY ^{60}Co γ-RADIATION. PART 1. PURE METHYL OLEATE. **Hyde, S. M.; Verdin, D. (United Kingdom Atomic Energy Authority, Wantage, Eng.). Trans. Faraday Soc., 64: 144-54(Jan. 1968).**

The ^{60}Co γ-induced oxidation of pure methyl oleate at dose rates below 1.3×10^{18} eV $l.^{-1}$ sec^{-1} was shown to occur by a chain mechanism in which the O_2 absorbed is quantitatively converted to hydroperoxide at conversions up to about 8%. The reaction had an overall activation energy of 6.4 kcal/mole, and involved a temperature-independent production of initiating radicals from methyl oleate with a G-value of 5.36. $HO_2\cdot$ radicals did not participate on the initiation reaction since the yield of radiolytic hydrogen (G = 1.01) from methyl oleate was unaffected by the presence of O_2. The appearance of a peak in the absorption spectrum at 219 mμ is attributed to α,β-unsaturated ketones produced in the chain-termination reaction. The rate of oxidation of methyl oleate dissolved in methyl stearate, for which $G_{radical}$ was 5.24, increased linearly with the solute concentration. (auth) (UK)

16599 IONIC CONDENSATION OF OLEFINS BY IONIZING RADIATION. EFFECTS OF ADDITIVES AND THE DETAILED MECHANISM. **Wagner, C. D. (Shell Development Co., Emeryville, Calif.). Trans. Faraday Soc., 64: 163-74(Jan. 1968).**

The mechanism of olefin condensation initiated by the radical ion, $C_nH_{2n}^+$, was further supported by studies of the effects of additives on 1-pentene radiolysis. Radical scavengers inhibited formation of all of the dimeric products except 3-decene, formed with a G-value of 0.55. Electron scavengers in concentrations as low as 0.02 M increased this G-value up to a factor of 3; it is believed that they interfere with ion—electron recombination and increase the ion lifetime. Proton scavengers and certain unsaturated additives at about 1 M reduced the G-value by competitive reactions with the olefin ion. Structures of the straight-chain ionic dimer indicate that ionic dimerization proceeds with carbon—carbon bond formation between terminal carbons, with a single hydride migration of an originally allylic hydrogen. Condensation to form trimer and higher polymers requires development of branching. (auth) (UK)

16600 DIFFUSION OF XENON IN NEUTRON-IRRADIATED Cs HALIDES. PART 34 OF "RARE GASES IN SOLIDS". **Felix, F. W.; Meier, K. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 22A: 2075-7(Dec. 1967). (In German).**

The release of ^{133m}Xe and ^{133}Xe from neutron-irradiated single crystals of Cs halides was measured in function of temperature and neutron dose. This release could be expressed in terms of volume diffusion. The temperature dependence in CsF, CsBr, and CsI can be described by the activation energies ≤ 2, 1.45, and 1.14 eV and the frequency factors $\leq 1 \times 10^2$, 1×10^2, and 2.0 cm^2/sec in the temperature regions 450 to 600, 260 to 580, and 200 to 500°C, respectively. Increasing neutron doses decreased diffusion coefficients in CsBr and CsI. (auth)

16601 MEASUREMENT OF THE MEAN ENERGY REQUIRED TO PRODUCE AN ION PAIR IN CERTAIN DIELECTRIC LIQUIDS. **Mathieu, Jacques; Blanc, Daniel; Caminade, Pierre; Patau, Jean-Paul (Faculte des Sciences, Toulouse). J. Chim. Phys., 64: 1679-85(Nov.-Dec. 1967). (In French).**

A method is described for measuring the mean energy necessary to create a pair of ions in some dielectric liquids; in particular, in the hydrocarbons. The sample, purified and dried, is irradiated by gamma rays emitted by a cobalt-60 source, in a cell designed in such a way that the energy deposited in the liquid can be measured exactly. The results obtained at 25°C in a certain number of compounds are given; in particular, the alkanes, linear or ramified, and the aromatic hydrocarbons. (auth)

16602 ANISOTROPY OF DEFECT PRODUCTION IN ELECTRON IRRADIATED IRON. **Lomer, Jenifer N.; Pepper, M. (Univ. of Reading, Eng.). Phil. Mag., 16: 1119-28(Dec. 1967).**

Single crystals of α-iron, 10 to 25 μ thick, were irradiated along either the $\langle 100 \rangle$ or $\langle 111 \rangle$ directions with electrons in the energy range 0.3 to 2.0 MeV. The irradiations were carried out below 25°K, and the electrical resistivity change, as a function of electron dose, measured by a sensitive potentiometric technique. The results show distinct variations in damage rates according to the direction of irradiation. Computations were carried out, based on the theoretical calculations of Erginsoy et al. [Phys. Rev. A, 133, 595(1964)], of the anisotropy of the displacement energy for each of the incident directions of irradiation. Reasonable agreement between computed and experimental curves was obtained. (auth) (UK)

16603 EXCITED ELECTRONIC STATES OF BENZENE AND NAPHTHALENE. Birks, J. B.; Christophorou, L. G.; Huebner, R. H. (Oak Ridge National Lab., Tenn.). Nature (London), 217: 809-12(Mar. 2, 1968).

The excitation of the singlet and triplet π-electronic states of benzene and naphthalene by photons and by electrons is discussed in the light of recent experimental results, and new techniques are suggested for the observation of these excited states. (auth) (UK)

16604 NATURE OF THE ELECTRON TRAPS IN ALKALINE ICE. Barzynski, H.; Schulte-Frohlinde, D. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 22A: 2131-2(Dec. 1967). (In German).

The influence of the preparation of alkaline ice samples on the formation of trapped electrons on γ-irradiation was investigated. The formation of blue color due to trapped electrons was observed as a function of dose in glassy and crystalline samples of NaOH $3.5H_2O$ at −196°C. The defect or cavity model is favored as the best description of trapping sites for trapped electrons in alkaline ice. (M.C.G.)

16605 NATURE OF ^{32}P PRODUCED BY NEUTRON IRRADIATION OF SULPHUR. Ware, A. R.; Kendall, F. H. (Sir John Cass Coll., London). Int. J. Appl. Radiat. Isotop., 19: 123-8 (Feb. 1968).

A mild process for the extraction of radioactive phosphorus from irradiated sulphur was developed. The phosphorus-containing residues were examined by chemical analysis, chromatography, adsorption, and volatility studies. The possibility that phosphorus sulphides had been formed was ruled out by comparison of the chemical behaviour of irradiated sulphur with mixtures of active elementary phosphorus and sulphur, and known phosphorus sulphides. The presence of phosphates and other phosphorus compounds was investigated, and all the evidence points to the formation of an ortho-phosphate salt during irradiation. (auth) (UK)

16606 EFFECT OF DOSE-RATE, AND L.E.T., ON THE RADIATION-INDUCED CIS-TRANS ISOMERIZATION OF BUTENE-2 IN LIQUID BENZENE SOLUTION. Burns, W. G. (Atomic Energy Research Establishment, Harwell, Eng.); Cundall, R. B.; Griffiths, P. A.; Marsh, W. R. Trans. Faraday Soc., 64: 129-43(Jan. 1968).

Previous work with low dose-rate ^{60}Co γ rays showed that irradiation of cis-butene-2 dissolved in liquid benzene at room temperature causes isomerization to trans-butene-2, the G value rising with the concentration of cis-butene-2 to a plateau G(trans) = 2.4 at ≈0.3 mole/l of cis-butene-2. Experiments in which known triplet state scavengers (e.g., O_2, anthracene) were added suggested that the triplet state of benzene was the main agent of the isomerization, and the concentration dependence was attributed to the competition between the normal decay of the triplet state and reaction with cis-butene-2. The same measurements were made with a beam of 0.5-MeV protons as the radiation source, and G (trans) was found to be depressed at all concentrations of cis-butene-2, e.g., at 0.3 mole/l. G(trans) was 1.2. These results could be explained on the basis of diffusion and reaction of the species involved if the self-annihilation of triplet states occurred to form a singlet excited state and a ground-state molecule. Diffusion calculations show that for a normal spur size of ≈30 Å diameter the rate-constant for this reaction would be high, $\approx 10^{10}$ l mole^{-1} sec^{-1}. The effect of the decay of singlet states to form triplets during diffusion was considered. A dose-rate effect was also found with fast (2 to 4 MeV) electrons in the sense of lower values of G(trans) at high dose rate, and substantial effects were noted for effectively steady irradiation at 3.9×10^{20} eV cm^{-3} sec^{-1}. This dose rate was much lower than that expected on the above-suggested mechanism, using the rate constants needed to explain the LET effect with protons. It is suggested that radicals formed in the bulk of the solution at high dose rates are efficient quenching agents of excited states, and that the effective collision diameter for the quenching of excited molecules by radicals is ~100 Å. (auth) (UK)

16607 GAS-PHASE PHOTOLYSIS AND RADIOLYSIS OF ISOBUTANE. Lias, S. G.; Ausloos, P. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 48: 392-400(Jan. 1, 1968).

The photolysis of $(CH_3)_3CH$, $(CH_3)_3CD$, and of $(CH_3)_3CH-(CD_3)_3CD$ and $(CD_3)_3CD-H_2S$ mixtures was investigated at 1470 Å (8.4 eV), 1236 Å (10.0 eV), and 1048 to 1067 Å (11.6 to 11.8 eV). Since irradiating photons in these experiments have energies both higher and lower than the ionization energy of isobutane (10.6 eV), the modes of decomposition of the "superexcited" molecule can be compared with those of the molecule excited to states below the ionization potential. On the basis of isotopic analyses of the major products, it was determined that the following primary modes of decomposition of the excited isobutane molecule occur in the photolysis at all three energies: $i\text{-}C_4H_{10}^* \rightarrow CH_4 + C_3H_6$; $i\text{-}C_4H_{10}^* \rightarrow C_3H_8 + CH_2$; $i\text{-}C_4H_{10}^* \rightarrow CH_3 + \text{sec-}C_3H_7$; $i\text{-}C_4H_{10}^* \rightarrow H_2 + i\text{-}C_4H_8$. Most of the propyl radicals decompose further: $C_3H_7 \rightarrow H + C_3H_6$; $C_3H_7 \rightarrow CH_3 + C_2H_4$. An increase in photon energy increases the relative importance of C−C cleavage processes. The parent ions formed in the photolysis with 11.6 to 11.8-eV photons decompose to form $C_3H_6^+$ and sec-$C_3H_7^+$. The $C_3H_6^+$ ions react with isobutane to form sec-C_3H_7 radicals or propane: $C_3H_6^+ + i\text{-}C_4H_{10} \rightarrow CH_3CHCH_3 + C_4H_9^+$; $C_3H_6^+ + i\text{-}C_4H_{10} \rightarrow C_3H_8 + C_4H_8^+$. The probability of the former reaction is 1.5 times that of the latter, in agreement with a value for this ratio derived from the radiolysis of $C_4D_{10}-H_2S$ and $C_4H_{10}-C_4D_{10}$ mixtures. The role of superexcited molecules in the radiolysis is discussed and it is estimated that the number of dissociating neutral excited molecules per ion pair is no greater than 0.46. (auth)

16608 RATE CONSTANTS OF THE REACTIONS OF SOME DYES WITH HO_2 RADICALS AND HYDRATED ELECTRONS, FORMED BY ^{60}Co γ RADIOLYSIS OF AQUEOUS SOLUTIONS. Rakintzis, Nikolaus Th. (Nuclear Research Center Democritos, Athens). Z. Phys. Chem. (Frankfurt), 57: 99-102(Jan. 1968). (In German).

Radiolysis of aqueous dye solutions was carried out to determine the effects of HO_2 radicals on the dye and the rates of the reactions. The rates were much slower than those for OH radicals. Calculated values for rates of reactions of hydrated electrons with dyes are presented. (M.C.G.)

16609 ELECTRON PARAMAGNETIC RESONANCE INVESTIGATIONS OF SOME IRRADIATED UNSATURATED COMPOUNDS. Istratoiu, Rodica; Farcasiu, Malvina; Nicolau, Cl. (Centre of Radiobiology and Molecular Biology, Bucharest). Rev. Roum. Chim., 12: 1429-34(Dec. 1967).

A number of polycrystalline N-substituted maleimides and maleamic acids were synthetized and irradiated with ^{60}Co γ rays. The radioinduced free radicals were identified by means of electron paramagnetic resonance (EPR) spectroscopy. They were shown to be formed by hydrogen addition to the double bond of the compounds investigated. (auth)

16610 EFFECTS OF γ-RADIATION ON METAL DERIVATIVES OF α, β, γ, δ-TETRAPHENYLPORPHIN. Yamamoto, Kiyoko; Tsuruoka, Yukiko. Sci. Pap. Inst. Phys. Chem. Res. (Tokyo), 61: 100-13(Sept. 1967).

Gamma-induced radiolysis on α, β, γ, δ-tetraphenylporphin (TPP), its cobalt (II, III), nickel (II), copper (II), zinc (II), and silver (II) derivatives in deaerated dioxane was studied spectroscopically in the visible region. Effects of γ radiation on TPP, Co-, Ni-, Cu- and Zn-TPP were compared. It was concluded that the molecules of metal derivatives of porphyrin are distorted in some cases and not distorted in other cases, because M−N bonds in them are formed to have typical structures resulting from coordination tendencies of their ligands and their metal ions. (auth)

16611 RECOIL BEHAVIOR OF DIFFERENT ISOTOPES IN METAL HEXACARBONYLS. Harbottle, Garman (Brookhaven National Lab., Upton, N. Y.); Zahn, Ursel. Contract AT-30-2-Gen-16. Radiochim. Acta, 8: 114-16(Nov. 1967). (BNL-11467).

^{49}Cr, ^{51}Cr, ^{99}Mo, and ^{11}C parent compound retentions were observed after 2-BeV proton bombardment of $Cr(CO)_6$ and $Mo(CO)_6$. In addition, retentions of ^{49}Cr, ^{11}C, ^{15}O, and ^{51}Cr in $Cr(CO)_6$ after irradiation with 50-MeV bremsstrahlung and with neutrons were determined. Data are listed in tables. A mechanism is suggested for the back-reaction of recoil fragments to re-form metal hexacarbonyls after different nuclear transformations. (M.C.G.)

16612 CHEMICAL EFFECTS OF THE (n,p) REACTION IN CHLORODERIVATES OF PARAFFINS. Kronrad, Leo (Nuclear Research Inst., Rez, Czechoslovakia). Radiochim. Acta, 8: 89-93 (Nov. 1967).

Alkyl chlorides were activated by the reaction $^{35}Cl(n,p)^{35}S$. Chemical separations were performed to determine the nature of the products of the hot atom reactions. (auth)

16613 THIN-LAYER CHROMATOGRAPHY AS AN AID IN RADIOCHEMISTRY. PART 2. INVESTIGATION OF THE PRODUCTS OF NEUTRON IRRADIATION OF SOME INORGANIC

SALTS. Seiler, H.; Seiler, M. (Univ., Basel). Helv. Chim. Acta, 50: 2477-81(Oct. 1967). (In German).

The chemical fate of sodium pyrophosphate and sodium salts of chloro acids in neutron irradiation, and the influence of the presence of metal ions was investigated by using thin layer chromatography for separations of reaction products, and radiometric measurements. (auth)

16614 CHEMICAL CHANGES OF SULFUR ATOMS IN SILVER CHLORIDE DOPED WITH SULFIDE–^{35}S AND SULFATE–^{35}S. I. COMPARISON OF DOPED AND NEUTRON IRRADIATED SAMPLES. Kronrad, Leo; Kacena, Vladimir (Nuclear Research Inst., Rez, Czechoslovakia). Radiochim. Acta, 8: 93-6(Nov. 1967).

The changes of valency states of sulfur atoms present in doped AgCl as sulfide-^{35}S and sulfate-^{35}S were studied. During annealing sulfur atoms underwent changes similar to ^{35}S atoms produced in the ^{35}Cl(n,p)^{35}S nuclear reaction. (auth)

16615 RADIATION-CHEMICAL SOLUTION OF THE MICHAELIS–ARBUSOV REACTION. Caspari, G.; Drawe, H.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin. Sektor Strahlenchemie, Berlin). Radiochim. Acta, 8: 102-6(Nov. 1967). (In German).

Aryl halides were reacted with various alkyl phosphites under the influence of ^{60}Co γ rays and the resulting phosphonates formed by the Michaelis–Arbusov reaction were isolated. The radiation-chemical yield generally amounted to 1 to 10 molecules/100 eV. However, G-values of several hundred for the formation of phenyl phosphonate from trialkyl phosphite + iodobenzene were obtained. The G-value of this reaction was proportional to the square root of the reciprocal dose rate and increased with decreasing temperature. A mechanism is discussed according to which the reaction occurs as a chain process in the case of the aryiodides. (auth)

16616 PRODUCTION OF CARRIER-FREE ^{114m}In BY SZILARD-CHALMERS ENRICHMENT FROM METAL PHTHALOCYANINES. Muehl, P.; Grosse–Ruyken, H. (Institut fuer Metallphysik und Reinstmetalle, Dresden. Technische Univ., Dresden). Isotopenpraxis, 3: 486-90(Dec. 1967). (In German).

The enrichment of ^{114m}In by the Szilard–Chalmers reaction was studied by using indium phthalocyanine as the target. The samples were irradiated in the core of a nuclear reactor. By enrichment, specific activities were obtained which are available but by long-termed irradiation times. The specific activity was investigated as the function of irradiation time, type and pretreatment of the target compound, duration of storage of the exposed samples, and separation process. (auth)

16617 BEHAVIOR OF TRAPPED ELECTRONS IN IRRADIATED 3-METHYLPENTANE GLASS AT 77°K. Irie, Masahiro (Kyoto Univ.); Hayashi, Koichiro; Okamura, Seizo; Yoshida, Hiroshi. J. Chem. Phys., 48: 922-6(Jan. 15, 1968).

Formation and decay of trapped electrons in 3-methylpentane glass irradiated by γ rays were studied by the electron spin resonance method at 77°K. In pure 3-methylpentane, the trapped electrons decayed by first-order reactions. Observed decay curves are clearly the superposition of two reactions having first-order rate constants of 0.2 and about 0.04 min^{-1}, respectively. The yield of trapped electrons (G value) is 0.14 for the fast decaying part and 0.09 for the slow decaying part. The addition of a small amount of 2-methylpentene-1 slowed down remarkably the decay of the slowly disappearing electrons, whereas the decay of the fast disappearing ones was not affected. It is indicated that the latter electrons are intrinsic to the nature of the 3-methylpentane glass, being bound in shallow traps, and their decay is caused by migration of the electrons themselves. The former electrons are trapped deeply in anomalous sites in the glass such as impurity sites. Their decay is caused mainly by the migration of positive charges. (auth)

16618 ELECTRICAL AND PHOTOELECTRICAL PROPERTIES OF MONOCRYSTALS OF P-TYPE SILICON IRRADIATED WITH FAST NEUTRONS. Sevchenko, A. N.; Tkachev, V. D.; Lugakov, P. F. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk BSSR, 11: 13-15(Jan. 1967). (In Russian).

The electric and photoelectric properties of monocrystals of p-type silicon subjected to fast neutron radiation were studied. Curves were obtained showing the dependence of the electrical resistance of the crystals on the amount of radiation. Spectra of the photoconductivity of p-type silicon after subjection to radiation intensities of 10^{15} neutrons/cm^2, 10^{16} neutrons/cm^2, 10^{17} neutrons/cm^2 in the absence of short-wave illumination and in the presence of short-wave illumination were also obtained. (JPRS)

16619 RETENTION AND ISOTOPIC EFFECTS OF THE (n,γ) REACTION IN VARIOUS TIN COMPOUNDS. Bogdanov, R. V.; Bondarevskii, S. I. Radiokhimiya, 9: 521-2(1967). (In Russian).

Water-cooled targets of SnCl$_2$, SnO, and $(C_6H_5)_4$Sn were irradiated 5 hr at a reactor flux of 3×10^{13} n/cm^2 sec and chemically processed. Measurements of the ^{119m}Sn, ^{117m}Sn, and ^{113}Sn contents of the fractions containing the different valence states showed similar isotope effects in the (n,γ) reaction with the divalent tin compounds, SnO and SnCl$_2$; the ^{117m}Sn retention was significantly less than that of ^{119m}Sn and ^{113}Sn, and the ^{113}Sn was higher than the ^{119m}Sn. Results were different with the tetravalent tin compound, tetraphenyltin; as the atomic weight of the radioactive isotope decreased, its retention decreased. Further study on additional organic and inorganic divalent and tetravalent tin compounds is needed for clarification of the basis of the isotope effect. (TTT)

16620 REACTION OF NITROUS OXIDE WITH EXCITED MOLECULES IN THE RADIOLYSIS AND PHOTOLYSIS OF LIQUID ALKANES. Holboyd, R. A. (Atomics International, Canoga Park, Calif.). J. Phys. Chem., 72: 759-61(Feb. 1968).

Solutions of nitrous oxide in several alkanes (cyclohexane, n-hexane, and 2,2,4-trimethylpentane) were photolyzed at 1470 Å and the results compared to the radiolysis of these solutions. The photochemical experiments suggest that in radiolysis a reaction of nitrous oxide with excited molecules would be expected in cyclohexane but should be less important in 2,2,4-trimethylpentane. At nitrous oxide concentrations less than 10 m$\underline{M}$, where reactions of excited molecules are unimportant, G(N$_2$) was the same for cyclohexane and 2,2,4-trimethylpentane solutions. At concentrations of N$_2$O from 20 to 160 m$\underline{M}$, G(N$_2$) from cyclohexane solutions was greater than G(N$_2$) from 2,2,4-trimethylpentane solutions, and the excess yield increased with the concentration of N$_2$O. These results are interpreted to mean that in the radiolysis, N$_2$O scavenges electrons in both alkanes but also scavenges excited molecules in cyclohexane. (D.H.M.)

16621 EXCITED-MOLECULE REACTIONS IN THE RADIOLYSIS OF PEPTIDES IN CONCENTRATED AQUEOUS SOLUTION. Rodgers, Michael A. J.; Garrison, Warren M. (Univ. of California, Berkeley). J. Phys. Chem., 72: 758-9(Feb. 1968). (UCRL-17886).

The γ-radiolysis of oxygen-free solutions of acetylalanine was studied. There was a marked increase in the ammonia yield (measured after hydrolysis) as the concentration of the acetylalanine was increased above 1$\underline{M}$. The ammonia yield tended to level off at a value of G(NH$_3$) ~ 3 in the concentration range from 2 to 3$\underline{M}$. This increase in G(NH$_3$) was not accompanied by a corresponding increase in the yield of carbonyl products; G(>CO) ~ 0.7 over the entire concentration range 0.1 to 3$\underline{M}$. The effects of formate ions, chloroacetate ions, naphthalenesulfonic acid, and change in acidity on the yields were investigated. (D.H.M.)

16622 HIGH INTERNAL EXCITATION ENERGIES OF PRODUCTS FOLLOWING ENERGETIC SUBSTITUTION OF TRITIUM FOR HYDROGEN IN METHYL ISOCYANIDE. Ting, Cheng T.; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Phys. Chem., 72: 763-5(Feb. 1968).

A study of energetic tritium reactions with methyl isocyanide is reported. Typical distribution of radioactive products from recoil tritium reactions with methyl isocyanide are tabulated for several sets of experimental conditions. Although the substitution reaction $CH_2TNC^* \rightarrow CH_2TCN$ was observed in the liquid phase, no detectable yield of CH$_2$TNC was found in the gas phase. The isomerization product CH$_2$TCN was found in both gaseous and liquid phases. It was generalized that the replacement of H atoms by energetic T atoms probably does not take place in any system except by reactions leaving the product molecule with at least 2 or 3 eV excitation energy. This energetic requirement can well be the direct consequence of the formation of C–T bonds involving angular deflections that are extremely large, i.e., the creation of the new bond with extremely high vibrational energy of the T–C–X bonds. (D.H.M.)

16623 ELECTRON CAPTURE PROCESSES IN IRRADIATED GASEOUS HCl. Johnson, G. R. A.; Redpath, J. L. (Univ. of Newcastle-upon-Tyne, Eng.). J. Phys. Chem., 72: 765-6 (Feb. 1968).

An explanation for the decrease in the yield of H$_2$ in the γ-radiolysis of HCl gas by low concentrations of SF$_6$ is presented. At the pressures of HCl used in the radiolysis, a hydrogen-bonded agglomerate of HCl may be involved in the reaction with thermal electrons, which may be represented by $e^- + nHCl \rightarrow H + Cl^-(n-1)HCl$. Evidence in support of such a process is presented. (D.H.M.)

16624 CHEMILUMINESCENT REACTIONS OF FLUORESCEIN DYES IN AQUEOUS SOLUTION. Grossweiner, L. I.; Rodde, A. F. Jr. (Michael Reese Hospital and Medical Center, Chicago). J. Phys. Chem., 72: 756-8(Feb. 1968).

A combined flash photolysis–pulse radiolysis experiment was performed in which deaerated dye solution was irradiated first with 15-μsec flash of visible light (>400mμ) followed by a 1-μsec pulse of 33-MeV electrons (~150 RAD). Optical emission and absorption measurements were made during the process. The flash illumination of 2 to 5μM fluorescein or eosin led to the excitation of triple dye, which decays with the formation of semioxidized dye (X) and semireduced dye (R). Addition of 250 μM formate strongly quenched the emission from both dyes when the electron pulse was applied at a time delay of 1 to 5 msec. At this time the triplet had decayed but R and X had not reacted appreciably. Since formate suppresses only that oxidized dye formed by radiolysis, this result proves that the OH adduct is the reacting species. Further investigation showed that a strong light emission occurred at shorter delay times, even with high formate present to suppress all oxidation of the dye by OH. This process is attributed to the reaction of triplet dye with e_{aq}^- leading to electronically excited semiquinone. (D.H.M.)

16625 ION-SOLVENT-MOLECULE INTERACTIONS IN THE GAS PHASE. ENTHALPIES AND ENTROPIES FOR THE REACTIONS $NH_4^+(NH_3)_{n-1} + NH_3 = NH_4^+(NH_3)_n$. Searles, S. K.; Kebarle, P. (Univ. of Alberta, Edmonton). J. Phys. Chem., 72: 742-3(Feb. 1968).

The proton-beam mass spectrometer was used to obtain thermodynamic data on the gas-phase reaction $NH_4^+(NH_3)_{n-1} + NH_3 = NH_4^+(NH_3)_n$ in the temperature range from −50 to 500°C. Thermodynamic quantities for reactions 0,1 to 4,5 are tabulated. Results are compared with recently reported work on the system $H^+(H_2O)_w$. (D.H.M.)

16626 ELECTRON SPIN RESONANCE AND OPTICAL STUDIES OF t-BUTYL PEROXIDE IONS PRODUCED BY γ IRRADIATION. Shida, Tadamasa (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Chem., 72: 723-7(Feb. 1968).

Di-t-butyl peroxide in rigid matrices of ethers, amines, and hydrocarbons at −196°C captures electrons ejected from matrix molecules by γ irradiation and forms the molecular anion of the peroxide. The anion absorbs at about 560 mμ. In alcoholic matrices the anion is also formed, but it reacts further with alcohol by the reaction $t\text{-BuOO-}t\text{-Bu}^- + CH_3OH \rightarrow t\text{-Bu}\cdot + t\text{-BuOH} + CH_3O^-$, followed by $t\text{-Bu}\cdot + CH_3OH \rightarrow t\text{-BuOH} + \cdot CH_2OH$. In matrices where positive charge produced by ionization can migrate to additives, the solute peroxide is ionized by accepting the migrating positive charge. When both anion and cation are formed, subsequent photobleaching of the anion releases electrons and induces the reaction $t\text{-BuOO-}t\text{-Bu}^+ + e^- \rightarrow t\text{-BuO}\cdot + t\text{-BuO}\cdot^*$, $t\text{-BuO}\cdot^* \rightarrow \cdot CH_3 + CH_3COCH_3$. t-Butyl hydroperoxide also captures electrons. Instead of the anion formation, however, the reaction $t\text{-BuOOH} + e^- \rightarrow t\text{-BuO}\cdot + OH^-$ takes place. (auth)

16627 RATE CONSTANTS OF OH WITH HO_2, O_2^-, AND $H_2O_2^+$ FROM HYDROGEN PEROXIDE FORMATION IN PULSE-IRRADIATED OXYGENATED WATER. Sehested, Knud (Atomic Energy Commission Research Establishment, Riso, Denmark); Rasmussen, Ole Lang; Fricke, Hugo. J. Phys. Chem., 72: 626-31(Feb. 1968).

The rate constants for the reactions of OH with HO_2, O_2^-, and $H_2O_2^+$ were calculated from measurements of $G(H_2O_2)$ in oxygenated water irradiated at 25°C with a pulsed electron beam in the pH range 0.46 to 6.75 and at dose rates between 500 and 5000 RADs/pulse. At these dose rates, HO_2 remained in equilibrium with its ionized and protonated forms during these reactions. Above pH 2.74, $G(H_2O_2)$ decreased, owing to the dissociation of HO_2. Based on $k(OH + OH) = 0.60 \times 10^{10}\ M^{-1}\ sec^{-1}$, $k(OH + HO_2) = 0.71 \times 10^{10}\ M^{-1}\ sec^{-1}$, $k(OH + O_2^-) = 1.01 \times 10^{10}\ M^{-1}\ sec^{-1}$, and $pK = 4.45 \pm 0.10$ for $HO_2 \rightleftharpoons H^+ + O_2^-$ were obtained. Results at pH 1.51 and 0.46 support Bielski and Allens's suggestion that HO_2 protonates in this pH region and give a $pK = 1.20 \pm 0.30$ for $H_2O_2^+ \rightleftharpoons HO_2 + H^+$ and the rate constant $k(OH + H_2O_2^+) = 1.27 \times 10^{10}\ M^{-1}\ sec^{-1}$. (auth)

16628 SOME UPPER LIMITS FOR THE SINGLE-STEP DOUBLE-DISPLACEMENT REACTION IN RECOIL TRITIUM SYSTEMS. Tang, Y.-N.; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Phys. Chem., 72: 707-13 (Feb. 1968).

A search for the single-step double-displacement reaction in recoil tritium reactions yielded upper limits of 0.1% of the total tritium for $CH_3CH = CHT$ from $n\text{-}C_3H_7Cl$ or $i\text{-}C_3H_7Cl$ and for $CH_2ClCH = CHT$ from $n\text{-}C_3H_7Cl$. The rather small pressure dependence of the product yields from recoil tritium reactions with CH_4 was shown to be consistent with secondary decomposition of CH_3T^*. No positive evidence for the single-step double-displacement reaction was found in recoil tritium systems. (auth)

16629 THE RADIOLYSIS OF SOME HEAVY WATER SOLUTIONS AT pD 1.3 TO 13. Draganic, Z. D.; Micic, O. I.; Nenadovic, M. T. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). J. Phys. Chem., 72: 511-17(Feb. 1968).

The yields of primary products in heavy water γ radiolysis were determined over the pD range from 1.3 to 13. Various combinations of the following scavengers were used: Cu^{2+}, Br^-, oxalic acid, ethanol, and oxygen. Results were compared with the corresponding values from previous work with the same systems in light water solutions, and the following ratios of primary yields were obtained: $G_{-H_2O}/G_{-D_2O} = 1$, $G_R^{H_2O}/G_R^{D_2O} < 1$, and $G_M^{H_2O}/G_M^{D_2O} > 1$. Relative rate constants were determined for some reactions of D, OD, e_{aq}^-, O^- ion radicals, and the isotopic effect is discussed. (auth)

16630 REACTION OF THE DEUTERATED ELECTRON, e_d^-, WITH e_d^-, D, OD, AND D_2O. Hart, Edwin J.; Fielden, E. M. (Argonne National Lab., Ill.). J. Phys. Chem., 72: 577-83(Feb. 1968).

The reaction of the deuterated electron, e_d^- with e_d^-, D, OD, and with D_2O was studied by pulse radiolysis techniques. These rate constants at 23 ± 2°C are 6×10^9, $2.8 \pm 0.2 \times 10^{10}$, $2.8 \pm 0.2 \times 10^{10}$, and $1.25 \pm 0.50\ M^{-1}\ sec^{-1}$, respectively. The rate constant of e_d^- with D was obtained at pD 9.39 in the presence of 0.0045 M D_2, that with OD at pD 11.15 in the absence of D_2, and that with D_2O at pD 0.39 in D_2 saturated solutions. While the reactions of e_d^- with D and OD are nearly identical with those of e_{aq}^- with H and OH, its reaction with D_2O is an order of magnitude lower. (auth)

16631 PROCESS FOR PREPARING GRAFTED VINYL ALCOHOL-OLEFIN COPOLYMERS. (to Kurashiki Rayon Kabushiki Kaisha). British Patent 1,101,088. Jan. 31, 1968. Priority date Mar. 16, 1964, Japan.

A process for preparing a grafted vinyl alcohol–olefin copolymer suitable for the preparation of shaped articles having good impact resistance is presented. The vinyl alcohol–olefin (ethene, propene, or butene) copolymer was electron-irradiated and contacted with a monomer that was a conjugated diene or derivative thereof. The impact strength of the moulding of a graft vinyl alcohol–ethene copolymer obtained by the process showed about 10 times the ordinary strength and the moulding of grafted vinyl alcohol–propene copolymer was 7 times the ordinary strength. (D.H.M.)

16632 ISOTOPES AND RADIATION TECHNOLOGY. Volume 5, Number 2. Baker, P. S.; Lafferty, Robert H. Jr.; Gerrard, Martha; Greene, R. E.; McKinney, F. E.; Carden, Joan E.; Miller, F. J.; Rupp, A. F. (eds.). Contract W-7405-eng-26. One of the Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab., Winter 1967-68. 166p. GPO $0.70.

Sixteen articles are included; separate abstracts were prepared for each. Separate abstracts were not prepared, though, for the Miscellaneous Section, which contains brief information on conferences, availability of isotopes and services, and AEC activities. (P.C.H.)

For abstracts of individual papers see: 16421, 16422, 16633–16635, 16651, 16652, 16741–16743, 16777–16779, 16789, 17063, and 17064.

16633 RADIOISOTOPES: 1980. Rupp, A. F. (Oak Ridge National Lab., Tenn.). Isotop. Radiat. Technol., 5: 89-91 (Winter 1967-68).

Radioisotope production and markets for the future are discussed. A slow, steady growth in the use of radioisotopes for medicine, industry, and research, but with no spectacular increase in rate during the next decade, is predicted. The use of large amounts of radioisotopes for radiation processing and isotopic power will become increasingly price dependent, growth curves being modified by competitive devices, processing economics, and actions taken by the safety regulatory bodies. The amount and kind of progress made in the radioisotopes business since about the time of the First Geneva Conference in 1955 is discussed briefly. (P.C.H.)

16634 MANUFACTURE OF RADIOISOTOPES, SOURCES, AND LABELED COMPOUNDS IN CZECHOSLOVAKIA. Chorvat, Karol (Inst. for Radioisotope Research, Production, and Utilization, Prague). Isotop. Radiat. Technol., 5: 155-7(Winter 1967-68).

The increase in manufacture and use of radioisotopes, radiation sources, and labeled compounds in Czechoslovakia is discussed. Although about 90 different nuclides are now being used, there is a relatively high and constant demand for ^{60}Co, ^{131}I, and ^{198}Au. The demand is increasing for ^{192}Ir and for other isotopes as a whole, although that for ^{32}P and ^{35}S is falling. (P.C.H.)

16635 PRODUCTION AND SALES OF RADIOELEMENTS IN FRANCE. Isotop. Radiat. Technol., 5: 158-9(Winter 1967-68).

A brief review is presented on the production and sales of radioisotopes in France. Particular attention is given to the growth of radioisotope sales. Methods for producing radioisotopes are briefly discussed. (P.C.H.)

16636 ISOTOPES AND RADIATION TECHNOLOGY. Volume 5, Number 3. Baker, P. S.; Lafferty, Robert H. Jr.; Gerrard, Martha; Greene, R. E.; McKinney, F. E.; Carden, Joan E.; Miller, F. J.; Rupp, A. F. (eds.). One of the Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab., Spring 1968. 98p. GPO $0.70.

Fifteen articles are included; separate abstracts were prepared for 13. One article on the five-year program for radioisotope production at the Australian Research Establishment was previously abstracted in NSA as 21: 27991. A miscellaneous section is included that gives information on conferences, AEC activities, and availability of isotopes and services. (P.C.H.)

For abstracts of individual papers see: 16423, 16637–16639, 16699, 16744, 16745, 16780, 16790, 16860, 16921, 17065, and 17066.

16637 RADIOISOTOPES AND RADIATION DEVELOPMENTS IN THE USA: 1967. Fowler, E. E. (U. S. Atomic Energy Commission, Washington, D. C.). Isotop. Radiat. Technol., 5: 169-84(Spring 1968).

A general survey is given of the U. S. program on radioisotopes and radiation developments in 1967. Three main phases of the program are presented: development, as well as present emphasis and future trends, of the U. S. Atomic Energy Commission's research and development program in isotopes and radiation technology; status and trends in current uses of isotopes, both by industry and government; and current status of production and sales of radioisotopes and radiation sources. (auth)

16638 RADIATION AND RADIOISOTOPES IN CANADA. Isotop. Radiat. Technol., 5: 255-8(Spring 1968).

The use of radiation and radioisotopes in industry, medicine, and research in Canada, along with the production and shipment of radioisotopes is discussed. The growth rate of radioisotope shipments in Canada is indicated. (P.C.H.)

16639 PRODUCTION AND USE OF RADIOISOTOPES IN SPAIN, 1964–1965. Gerrard, Martha. Isotop. Radiat. Technol., 5: 258-60(Spring 1968).

The production and use of radioisotopes and labeled materials in Spain during the two-year period 1964–1965 are discussed. The use of radioisotopes in industry is also mentioned. (P.C.H.)

Radiochemistry

Refer also to abstracts 16564, 16565, and 16777.

16640 SYSTEMATIC POSITRONIUM CHEMISTRY. Tao, S. J.; Green, J. H. (New England Inst. for Medical Research, Ridgefield, Conn.). J. Chem. Soc., A, No. 2, 408(1968).

A different conceptual basis is outlined for chemical reactions between positronium and ionic or neutral species in liquids. It is first shown that the positronium formation fraction in pure liquids depends not only on the dissociation energy of the medium (Oré-gap theory), but also on the threshold, $I_A - I_P$, where I_A and I_P are the ionisation potentials of the liquid and positronium. The energy regions in which positronium reactions may occur are defined in terms of ionisation potentials and bond strengths of the constituents of the liquid and of positronium. Special features of positronium reactions are described, and general conditions and examples are given of oxidation of Ps by electron transfer, compound formation, and double decomposition, and of reduction. "Anomalous" features of earlier experimental data and recent experiments, are satisfactorily explained in terms of the new concepts. These concepts are then applied to describe the conditions for reactions in mixtures. The effects are additive, except when complexes are formed. A simple mathematical analysis is given to predict the effects on the experimental position annihilation lifetime data which depend on ortho-para conversion, pick-off, and compound formation. Experimental data are used, when available, to check the predictions. (auth) (UK)

16641 CHEMICAL EFFECTS OF BROMINE ACTIVATED BY ISOMERIC TRANSITION OF ^{82m}Br AND (n,γ) REACTION OF ^{81}Br IN LIQUID BROMOBENZENE. Leontiadis, Ioannis L.; Katsanos, Nicholas A. (Nuclear Research Center Democritos, Attikis, Greece). Z. Phys. Chem. (Frankfurt), 57: 38-48(Jan. 1968).

A method was developed for determining the separate chemical effects produced by activation of bromine atoms by the nuclear transformations ^{81}Br(n,γ)^{82m}Br and ^{82m}Br(I.T.)^{82}Br, in bromobenzene. In the latter case the effects due to the decay of organically bound ^{82m}Br can be distinguished from those due to the decay of inorganic ^{82m}Br. The former produce higher ^{82}Br organic retentions than the second, which gave retention values similar to those given by (n,γ) activation. The higher organic yield of ^{82}Br in the first case was exclusively due to the larger amount of the labeled parent compound. This is explained by assuming a high probability of recombination of ^{82}Br with the parent radical after bond rupture in this case. The similarity of retention values obtained in the other two cases is probably due to the great initial separation between the two parent fragments caused by the (n,γ) process. (auth)

Separation Processes

Refer also to abstracts 16386, 16507, 16529, 16554, and 16605.

16642 (BNWL-680, pp 7-12) INVESTIGATION OF NTA AS A REPLACEMENT FOR DTPA IN THE ION-EXCHANGE PURIFICATION OF PROMETHIUM. Wheelwright, E. J.; Myers, T. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Recent laboratory experiments showed that when NTA (nitrilotriacetic acid) is substituted for DTPA (diethylenetriaminepentaacetic acid) in a typical promethium purification flowsheet, the elution position of yttrium is moved to a place ahead of samarium, thus removing yttrium from the critical Sm-Pm-Nd zone of the rare earth spectrum. Data implied that the use of NTA for promethium processing would allow a 50 to 100% increase in the mass flow rate. Use of NTA would reduce eluate waste volumes and reduce chemical costs for the complexant by about 50%. (M.C.G.)

16643 (KFK-652) DAS VERHALTEN HOHER PLUTONIUM-KONZENTRATIONEN IM PUREX-PROZESS UND DIE ENTWICKLUNG SCHNELLER EXTRAKTOREN ZUR WIEDERAUFARBEITUNG VON KERNBRENNSTOFFEN. (The Retention of High Plutonium Concentration in the Purex Process and the Development of Rapid Extraction for Reprocessing of Nuclear Fuel). Baumgaertner, F.; Ochsenfeld, W.; Roth, B.; Finsterwalder, L. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Aug. 1967. 27p. (In German). (EUR-3683). Dep.

One of the primary problems in the reprocessing of fuel elements with high Pu concentrations by the Purex process is the recessive extraction behavior of Pu in the Pu–uranyl nitrate–TBP system. Fast extractors are one solution to the Pu retention. Two fast extractors, the compact centrifugal extractor and the hydrocyclone extractor, were developed and constructed. Their operational behavior is described. (J.S.R.)

16644 (ORNL-4075) UNIT OPERATIONS SECTION QUARTERLY PROGRESS REPORT, JULY-SEPTEMBER 1966. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 68p. Dep. CFSTI.

Separate abstracts were prepared for each of the six sections. (M.C.G.)

For abstracts of individual sections see: 16484, 16645–16647, 17159, and 17160.

16645 (ORNL-4075, pp 4-21) CHEMICAL ENGINEERING RESEARCH. (Oak Ridge National Lab., Tenn.).

Performance data on a scaled-up version of the stacked-clone solvent-extraction contactor are presented. Operation of an experimental 1.4-scale contactor is compared with that of previous 0.5- and full-scale experimental devices. Additional data obtained with the 0.5-scale experimental contactor and the full-scale stainless steel prototype contactor are also given. Scale-up primarily affects flow capacity. The 0.5- and 1.4-scale contactors have flow capacities equal to 40% and 120%, respectively, of that obtained with the full-scale device, using a [sodium nitrate, uranyl nitrate]–[TBP, Amsco] system. Mass-transfer stage efficiencies of the contactors are between 60% and 80% for all sizes, and are apparently not greatly affected by scale-up. (auth)

16646 (ORNL-4075, pp 22-3) BIOCHEMICAL SEPARATIONS. Hancher, C. W.; Weeren, H. O. (Oak Ridge National Lab., Tenn.).

The quaternary amine–diatomaceous earth packing used for the chromatographic separation of transfer-ribonucleic acids was unstable in contact with eluting solutions having a low sodium chloride concentration, but completely stable in contact with solutions having sodium chloride concentrations greater than 0.45M. Therefore, eluting-solution concentrations were increased slightly, and no further instability was observed. In runs made with stable packing, complete (or nearly complete) separation of leucine and phenylalanine transferribonucleic acids was consistently achieved. A total of 390 kg of cells of Escherichia coli B was harvested and phenolated to yield 10.8 kg of ethanol precipitate. Difficulty was encountered in attempting to grow these cells continuously because of a virus infection of the culture. (auth)

16647 (ORNL-4075, pp 24-37) POWER-REACTOR FUEL PROCESSING. (Oak Ridge National Lab., Tenn.).

The development of grind-leach processing of unirradiated fuels of the graphite-matrix type was advanced. An ORNL-built roll crusher of improved design was tested by crushing feed prepared by hammer-milling HTGR compacts. The permeability of ground fuel to nitric acid solutions was correlated with pressure drop. The recovery of thorium and uranium by deep-bed washing of ground fuel was measured at different temperatures and different concentrations of acid in the wash water. Work by others showed that uranium and thorium losses from grind-leach processing of irradiated fuel were unacceptably high; therefore, the method is probably limited to unirradiated fuel. However, these studies will be continued since a grinding operation may still be required in the processing of irradiated fuels that are composed of microspheres having a noncombustible layer in their coatings. (auth)

16648 (UJV–1312) EXTRACTION OF NITRIC ACID, URANIUM, PLUTONIUM, AND FISSION PRODUCTS BY PHOSPHONATES, PHOSPHINATES AND PHOSPHINE OXIDES. II. EXTRACTION OF PLUTONIUM. Talas, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [1967]. 17p. Dep.

Plutonium extraction by the dibutylester of butylphosphonic acid and the butylester of dibutylphosphinic acid was investigated. The extraction of plutonium (IV) nitrate from nitric acid solutions was studied as a function of the concentration of the acid, of the type and concentration of the salting-out agent and of the concentration of the solvent. The effect of sulfate ions was preliminarily investigated. Plutonium (IV) nitrate was extracted better than uranyl nitrate with both solvents. Both nitrates formed bisolvates with both solvents. Preliminary experiments were carried out on plutonium (III) nitrate extractions as a function of the nitric acid concentration. (auth)

16649 (ORNL-tr–1847) ^{237}Np. Chesne, Andre. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Ind. At., 10: No. 7-8, 71-9(1966). 11p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 46134. (P.C.H.)

16650 (ORNL-tr–1902) PREDICTIONS ON THE BEHAVIOR OF FIRST CYCLE SOLVENT DURING THE PROCESSING OF HIGHLY IRRADIATED FUELS. Salomon, L.; Vervecken, E.; Lopez-Menchero, E. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from report ETR–213. 72p. Dep. CFSTI. JCL $7.60 fs, $2.50 mf.

The dose rates received by the solvent in the HA column (1st Purex extraction cycle) were estimated for different burnups of the fuel. Experiments carried out with solutions irradiated to corresponding doses, showed that the "immediate degradation in the HA unit" affects the zirconium decontamination and the uranium retention in the organic phase essentially, and that the efficiency of the separation of uranium from plutonium is not changed to a noticeable extent. Furthermore, a study was done to develop a simple method that is the most suited to solve the problem of the increase in zirconium contamination in the uranium product if the activity of the HAF solution is increased; a pretreatment, consisting of the Zr selective precipitation by mandelic acid, was tested and gave promising results. (auth)

16651 SOLVENT EXTRACTION OF FISSION PRODUCTS. II. CESIUM. Miller, F. J. Isotop. Radiat. Technol., 5: 92-101(Winter 1967-68).

The liquid–liquid solvent extraction of fission-product cesium is discussed, chiefly from the standpoint of recovery of a potentially valuable radioisotope from nuclear energy fuel-reprocessing waste solutions. The basic principles covering the majority of extraction schemes are presented in detail. Specific extraction schemes—the dipicrylamine, tetraphenylboride, polyhalide, and substituted phenol, synergistic extraction, and chelation with subsequent extraction—are given with specific references. Some consideration is given to the safety of the solvents used. An attempt was made to correlate the extraction schemes with theory and to indicate a possible future line of work. (auth)

16652 CHEMISTRY OF THE ELECTROMAGNETICALLY SEPARATED STABLE ISOTOPES. Isotop. Radiat. Technol., 5: 101-3(Winter 1967-68).

A purification method is described for the stable isotopes of cerium electromagnetically enriched at Oak Ridge National Laboratory. The cerium oxide residue from the ignition of graphite pockets is dissolved in a mixture of HNO_3 and H_2O_2, precipitated as $Ce(OH)_4$ with ammonium hydroxide, and ignited to CeO_2. The CeO_2 is dissolved as before, precipitated as the oxalate, and ignited to CeO_2, the inventory form. (auth)

16653 PURIFICATION OF ZIRCONIUM IN OXYGEN BY DISTILLATION. Ailloud, Pierre; Renucci, Louis; Langeron, Jean-Paul (Centre d'Etudes de Chimie Metallurgique, Vitry-sur-Seine, France). Compt. Rend., Ser. C, 266: 366-8(Feb. 5, 1968). (In French).

A technique is described for the purification of zirconium in oxygen by distillation of the monoxide ZrO. The meltings, by induction, are carried out under static ultravacuum. This method was applied to a synthetic zirconium–oxygen mixture of 1275×10^{-4} wt % oxygen. After treatment for 20 hr at a temperature slightly above the melting point, the content of oxygen was reduced by 70% while the loss of weight of the sample was only 3.8%. It is thus possible to obtain, with a good yield, the purification in oxygen of small quantities of zirconium. (tr-auth)

16654 EXTRACTION OF URANYL SULFATE AND URANYL CHLORIDE BY TRIISOOCTYLAMINE IN SOLUTION IN THREE ORGANIC SOLVENTS. Vieux, Aliette S. (Faculte des Sciences, Kinshasa, Congo). Compt. Rend., Ser. C, 265: 1158-61(Nov. 20, 1967). (In French).

The extraction of uranyl sulfate and uranyl chloride by triisooctylamine (TIOA) in the three solvents benzene, xylene, and carbon tetrachloride was studied. The formula of the compounds extracted and the value of their dissociation constants were determined. (tr-auth)

16655 DEPENDENCE OF THE SEPARATION OF NITROGEN ISOTOPES ON THE TEMPERATURE OF THE COLUMN AND DESORBER AND THE VELOCITY OF FLOW OF COMPLEXES IN THE COLUMN. Kuznetsov, A. I.; Panchenkov, G. M. Zh. Fiz. Khim., 42: 245-8(Jan. 1968). (In Russian).

The dependence of the separation coefficient of nitrogen isotopes on the temperature and flow velocity of complexes in the column was investigated for systems formed by ammonia and its complexes with alcohol. Reduction of the temperature caused a slight increase in the distribution coefficients S and a great increase in the time of output of the column in the stationary state. A decrease of the flow velocity in the columns caused a significant increase in the parameter S and the time for the attainment of the steady state. The total separation coefficient depends on the temperature of the desorbent. The optimum temperature seems to be at 15 to 20°C, increasing with the boiling temperature of the alcohol. (tr-auth)

16656 SEPARATION OF BORON ISOTOPES BY CHEMICAL EXCHANGE METHODS. VI. COEFFICIENT OF THE ONE-TIME SEPARATION OF BORON ISOTOPES IN THE BF_3–$BF_3.C_6H_5OCH_3$ SYSTEM. Makarov, A. V.; Malinovskaya, G. F.; Panchenkov, G. M.; Kolchin, A. M. Zh. Fiz. Khim., 42: 295-7(Jan. 1968). (In Russian).

A device for determination of the separation coefficient α in a gas-liquid system by means of multistage tests in static conditions is described. During isotopic exchange of boron in the BF_3–$BF_3 \cdot C_6H_5OCH_3$ system, α is 1.025 ± 0.004 at 23°C. A method for the isotopic analysis of boron by means of the thermal decomposition of KBF_4 was described. (tr-auth)

16657 ISOTOPIC SEPARATION OF NITROGEN DURING NITRIC OXIDE SYNTHESIS IN HIGH-FREQUENCY ELECTRODE-FREE DISCHARGE. Melenevskii, V. N.; Tikhomirov, I. A.; Teploukhov, V. L. (Tomsk Polytechnic Inst., USSR). Zh. Fiz. Khim., 41: 2842-3(Nov. 1967). (In Russian).

Studies of nitrogen isotope distribution during nitric oxide synthesis in high-frequency electrode-free discharge indicated enrichment of NO by ^{15}N isotope. The experimental data obtained showed a nitrogen separation coefficient equal to 1.032 ± 0.008. (R.V.J.)

16658 EXTRACTION STUDIES OF ANTIMONY BROMIDE INTO BENZENE. Grimanis, Apostolos P.; Hadzistelios, Isidore (Democritos Nuclear Research Center, Athens). Anal. Chim. Acta, 41: 15-21(Apr. 1968).

Antimony(III) can be extracted rapidly and quantitatively into benzene from a 10 $\underline{M}$ H_2SO_4 – 0.03 $\underline{M}$ HBr system. The extracted antimony bromide has an antimony to bromine ratio of 1 : 3. Under the above optimum conditions for extraction of antimony, the behavior of 35 other elements was studied; As^{3+}, Ge^{4+}, Se^{4+}, and Sn^{2+} were extracted almost quantitatively, and the percentage extraction of Hg^{2+}, Bi^{3+}, and Te^{4+} was 74.1, 10, and 5.5%, respectively. The extraction of the elements into benzene from a 5 $\underline{M}$ H_2SO_4 – 0.01 $\underline{M}$ KI system was also investigated. A comparison of the two systems is given. (auth)

16659 SEPARATION OF NITROGEN ISOTOPES BY CHEMICAL EXCHANGE OF AMMONIA SOLUTIONS IN WATER AND ACETONE WITH AMMONIA. Kuznetsov, A. I.; Panchenkov, G. M. (Moscow State Univ.). Zh. Fiz. Khim., 41: 2990-2(Nov. 1967). (In Russian).

Nitrogen isotope separation was achieved by chemical exchange of NH_3 with its solutions in water and acetone. For the NH_3, $NH_3 \cdot H_2O$ systems in 135 cm column at 20°C and supply rate of 0.7 ml/min the coefficient of separation on the eighth day was equal to 1.56. For NH_3, $NH_3 \cdot CH_3COCH_3$ the separation effect was negligible due to the incomplete ammonia adsorption in thermal phase conversion. In all cases studied the heavy ^{15}N isotope was concentrated in the liquid phases. (R.V.J.)

16660 SOLIDIFICATION OF HIGH-LEVEL RADIOACTIVE WASTES. PART 4. ION DIFFUSION IN BASALT IN A RADIATION FIELD. Ralkova, J.; Saidl, J. (Institut fuer Kernforschung, Prague). Kernenergie, 10: 340-3(Nov. 1967). (In German).

The diffusion of strontium in melted basalt under irradiation conditions was studied. The radiation dose in the diffusion zone reached about 10^5 R/hr. The diffusion coefficients in the glass phase of the melted basalt agreed with those found without irradiation under the same conditions. The grinding technique used enabled the evaluation of individual diffusion processes in the recrystallized heterogeneous basalt. No change of the transformation interval and of the recrystallization temperature was found. The mechanical properties of the basalt remained unchanged under radiation influence. (auth)

16661 ABSORPTION OF TELLURIUM FROM ACID SOLUTIONS WITH WOFATIT-SBW. Jordanov, Chr. V.; Petkova, E. N. Neue Huette, 12: 335-7(1967). (In German).

The absorption of Te(IV) from acid solutions using the strongly alkaline anionite Wofatit-SBW was investigated. It was found that the Te can be removed best from 3.0N HCl at a filtration velocity of 0.2 ml/min and a concentration of the Te in the initial solution from 1 to 3 g/l. The anionite Wofatit-SBW absorbs no Se under these conditions and can be used for the selective separation of these two elements. By the use of acid and alkaline eluents for the desorption of Te, it was established that the best results can be obtained with a 1.0N acid solution. (tr-auth)

16662 LIQUID-LIQUID EQUILIBRIA. EXTRACTION OF ZIRCONIUM NITRATE BY TRIBUTYL PHOSPHATE. Stern, Martine (Faculte des Sciences, Paris). J. Chim. Phys., 64: 1734-9(Nov.-Dec. 1967). (In French).

The extraction of Zirconium from nitric solutions into a mixture of white spirit and Tributyl phosphate has been studied in a rather wide field of nitric acid concentrations. A series of relations has been drawn up, that allows us to connect the concentration of both phases after one extraction with the initial nitric acid and zirconium concentrations. (auth)

16663 PREFERENTIAL EXTRACTION OF LANTHANIDES OVER TRIVALENT ACTINIDES BY MONOACIDIC ORGANOPHOSPHATES FROM CARBOXYLIC ACIDS AND FROM MIXTURES OF CARBOXYLIC AND AMINOPOLYACETIC ACIDS. Weaver, Boyd; Kappelmann, F. A. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 30: 263-72(Jan. 1968).

In the extraction of lanthanides and trivalent actinides by monoacidic organophosphates from mineral acid solutions the distribution coefficients of the two groups of elements overlap, with americium behaving most like cerium or praseodymium. Substitution of carboxylic acids, especially hydroxy acids, for the mineral acids shifts the americium distribution coefficients downward slightly relative to the lanthanides. This effect becomes more pronounced with increasing pH. The presence of strongly-complexing aminopolyacetic acids causes a much larger shift, which increases with the number (at least up to five) of acetic acid groups in the complexing agent. Extraction by di(2-ethylhexyl) phosphoric acid (HDEHP) from lactic acid solutions containing the sodium salt of diethylenetriaminepentaacetic acid (DTPA) provides an effective system for completely separating the two groups of elements. Monoesters of phosphonic acids give similar preferential extraction of the lanthanides. Under conditions optimum for group separation, neodymium is the least extractable of the lanthanides and californium is the most extractable of the transplutonium elements. At a constant pH, extractions of americium, californium, and the middle lanthanides are inversely proportional to the DTPA concentrations from 10^{-4} to 10^{-1} M, while extractions of the other lanthanides vary so as to reverse the order of extractability of the lower lanthanides. With a constant DTPA concentration the difference between the extractability of americium and the middle lanthanides increases slowly with pH, while lanthanum and cerium gradually reverse their positions relative to the middle lanthanides. The extracted species contains a metal carboxylate complex. (auth) (UK)

16664 ELUTION REQUIREMENTS FOR THE RESOLUTION OF TERNARY RARE-EARTH MIXTURES. Powell, J. E. (Ames Lab., Iowa); Burkholder, H. R.; James, D. B. J. Chromatogr., 32: 559-66(Feb. 6, 1968).

The treatment employed by Powell and Spedding to establish the minimum number of displacements by displacement chromatography needed to resolve the components of binary rare earth mixtures has been extended rigorously to the case of ternary mixtures. (auth)

16665 SEPARATION OF SEVERAL RARE EARTHS BY EXTRACTION CHROMATOGRAPHY USING BIFUNCTIONAL PHOSPHINE OXIDES. O'Laughlin, Jerome W.; Jensen, Deanna F. (Ames Lab., Iowa). J. Chromatogr., 32: 567-76(Feb. 6, 1967).

The separation of milligram amounts of rare earth salts on short columns packed with various inert supports impregnated with methylenebis[(dihexyl)phosphine oxide], MHDPO, and methylenebis[bis(2-ethylhexyl)phosphine oxide], MEHDPO, is reported. The results showed that MHDPO and MEHDPO are useful stationary phases for the separation of milligram amounts of a number of the rare earths on small columns. The data also suggest that Plaskon and perhaps Kel-F are as useful as kieselguhr as supporting materials when the particle sizes of the various supports are comparable. The more inert nature of the fluorocarbon materials is a definite advantage over kieselguhr. (P.C.H.)

16666 ON THE EXTRACTION OF INORGANIC IONS BY N-(Di-n-BUTYLPHOSPHORO)SUCCINIMIDE, (N-DPBS). Belkas, E. P.; Perricos, D. C.; Tsolis, A. K. (Nuclear Research Center Democritos, Athens). Radiochim. Acta, 8: 116-18(Nov. 1967).

The compound N-(di-n-butylphosphoro)succinimide (N-DBPS) was studied as a potential extractant of 28 elements. The distribution ratios (D) are tabulated in a graph of log D versus molarity of nitric acid. (M.C.G.)

16667 CONVENIENT SEPARATION OF FISSION PRODUCT RHODIUM. Lyle, S. J.; Wellum, R. (Univ. of Kent, Canterbury, Eng.). Radiochim. Acta, 8: 119-20(Nov. 1967).

A method is described for the separation of rhodium from other fission products. It involves a trithallium hexanitritorhodate precipitation, subsequent thallium oxide scavenging, and, finally, precipitation of hexaamminecobalt hexanitritorhodate. The separation takes 30 to 40 min and yields of 50 to 60% were obtained. (M.C.G.)

16668 SEPARATION OF THE ELEMENTS ACTINIUM, THORIUM, PROTACTINIUM, AND URANIUM AFTER IRRADIATION OF A ^{231}Pa TARGET BY PROTONS. Hussonnois, Michel (Institut de Physique Nucleaire, Orsay, France). Radiochim. Acta, 8: 85-9(Nov. 1967). (In French).

A method was developed for the chemical separation of radionuclides of actinium, thorium, protactinium, and uranium, which are produced by irradiating protactinium with protons. The method permits a proper determination of these elements. After dissolving the target, the elements are readily separated into two groups by precipitating erbium fluoride: actinium and thorium are coprecipitated whereas protactinium and uranium stay in solution. Of the first group of elements only thorium can be retained by an anionic exchanger resin in a solution containing nitrate ions. The separation of erbium and actinium is achieved by amalgamation of actinium. Finally, protactinium and uranium can be separated from each other by extraction; the protactinium is extracted with methylisobutylacetone from a hydrochloric acid solution, the uranium is extracted with tributyl phosphate from a solution containing HCl and HF. All separations can be carried out in approximately two hours after irradiation giving yields of 70 to 80% for the elements in question. The method permits the preparation of carrier-free reference sources suitable for the measurement of alpha activities. (auth)

16669 A NEW Cs-SELECTIVE MINERAL ION EXCHANGE FOR THE DECONTAMINATION OF RADIOACTIVE WASTE. Levi, H. W.; Lutze, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Radiochim. Acta, 8: 82-5(Nov. 1967). (In German).

"Filtrolit" is a pelagonite tufa with ion-exchange properties that shows a particular selectivity for Cs. This material is excellent for use in columns. In many experiments on a laboratory scale as well as on a pilot-plant scale it was demonstrated that Filtrolit can be used for the decontamination of radioactive waste water containing Cs. Separation factors T^{Cs}_{Ca} were determined under static conditions as well as in columns. For the use of Filtrolit in columns the following empirical expression was found: $T^{Cs}_{Ca} \approx 2.5\sqrt{C_o^{Ca}/C_o^{Cs}}$. This expression permits the total Cs capacity of a column to be calculated for water with a given ratio of Cs : Ca. (auth)

16670 THE USE OF ZONE MELTING AND COLUMN CRYSTALLIZATION FOR PURIFICATION OF THE EUTECTIC KCl–LiCl MELT FROM DISSOLVED FISSIONABLE MATERIAL AND FISSION PRODUCT IMPURITIES. von Ammon, Reinhard (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). Radiochim. Acta, 8: 72-8(Nov. 1967). (In German).

Samples of KCl–LiCl eutectic containing small concentrations of UCl_4(UCl_3) or of the fission product chlorides CsCl, $BaCl_2$, $CeCl_3$, $RuCl_3$, and $ZrCl_4$ (0.2 to 0.8 wt % or tracer amounts) were zone melted. Effective distribution coefficients of 0.01 to 0.6 were obtained in the following order: $BaCl_2 < CsCl < UCl_4 = UCl_3 < CeCl_3 < ZrCl_4 < RuCl_3$. Tracer amounts gave the same results as macro concentrations. The method of column crystallization was applied to the same molten salt mixtures, in order to test the feasibility of using a multistage process that can be adapted to continuous operation for separation problems of molten salts. The depletion factors obtained for total reflux operation are in the region of 0.01 to 0.1, which is equal to only a few theoretical stages of the column. The comparatively poor stage effectivity of the column is attributed to experimental reasons. (auth)

16671 ELECTROPHORESIS OF RADIOACTIVE NUCLIDES. Buchtela, K. (Atominstitut der Osterreichische Hochschule, Vienna). Isotopenpraxis, 3: 482-6(Dec. 1967). (In German).

The rapid separation of mixtures of chemically very similar elements is possible by using high-voltage zone electrophoresis. Thus, as an example the complete separation of 15 elements from lanthanum to lutetium on cellulose acetate foils by high-voltage zone electrophoresis in 2-methyllactic acid is described. The time necessary for one separation process is 14 to 20 min. Application to the transuranium elements is mentioned. Sufficient results were obtained also for the chain products of natural radioactive families. Thus, a method was developed for separating the chain products of the actinium series, the use of which enabled the detection of ^{210}Pb impurities in commercial-grade ^{227}Ac. In other mother-daughter systems separation processes were made also for mass ratios as unfavorable as $10^6:1$. Uses in activation analysis are discussed. (auth)

16672 PAPER ELECTROCHROMATOGRAPHIC INVESTIGATION OF THE FORMATION OF COMPOUNDS OF URANIUM AND SOME ASSOCIATED ELEMENTS IN THE PRESENCE OF ACETIC ACID. I. SEPARATION OF UO_2^{2+} FROM Y^{3+}, Ce^{3+}, Fe^{3+}, Co^{2+}, Ni^{2+}, Cu^{2+}, Sr^{2+}, AND Cs^+. Marcu, Gh.; Botar, Al. (Laboratorium fuer Radiochemie des Chemische Instituts, Cluj). Rev. Roum. Chim., 12: 645-51(June 1967). (In German).

The electrochromatographic migration velocity of the investigated elements in $0.5\underline{M}$ acetic acid in the pH region from 2.14 to 6.01 was determined. It was established that under these conditions only the negatively charged complexes of the UO_2^{2+} ion with the composition $UO_2(CH_3COO)_3^-$, which migrates in an opposite direction to the remaining elements, can be formed. On the basis of these observations, a paper electrochromatographic method was developed for the rapid separation of uranium from Y, Ce, Fe, Co, Ni, Cu, Sr, and Cs. The best results were obtained in acetic acid at pH values from 3.56 to 3.84 and a potential value of 900 V on Whatman paper No. 5. The time required for the run was not more than 30 min. (tr-auth)

16673 PAPER CHROMATOGRAPHY OF INORGANIC SUBSTANCES. IV. THE R_F-VALUES OF INORGANIC IONS IN n-PROPANOL–HCl MIXTURES. Nascutiu, T. (Inst. for Atomic Physics, Bucharest). Rev. Roum. Chim., 12: 839-43(July 1967).

The R_F-values of 60 inorganic ions were determined by using the ascending technique on a Whatman No. 1 chromatographic paper and (1 : 1) n-propanol-1, 2, 4, 6, 8, and $10\underline{N}$ HCl mixtures. The obtained R_F-values were listed according to the position of elements in groups of the periodic system as well as the migration rates of the studied ions. The studied solvents, especially those having a high HCl concentration, give an efficient separation of a great number of the studied ions. (auth)

16674 PAPER CHROMATOGRAPHY OF INORGANIC SUBSTANCES. V. THE R_F-VALUES OF SEVERAL INORGANIC IONS IN t-BUTYL ALCOHOL-HYDROCHLORIC ACID SOLVENTS. Nascutiu, T. (Inst. for Atomic Physics, Bucharest). Rev. Roum. Chim., 12: 845-51(July 1967).

The R_F-values of 60 inorganic ions in solvents consisting of $\underline{t}$-butyl alcohol and 1, 2, 4, 6, 8, 10, and $12\underline{N}$ hydrochloric acid (1 : 1) and $\underline{t}$-butyl alcohol and $6\underline{N}$ or $8\underline{N}$ hydrochloric acid (2 : 1) were determined. The effectiveness of these solvents was compared with that of $\underline{n}$-butyl and isobutyl alcohol solvents. (auth)

16675 PAPER CHROMATOGRAPHY OF INORGANIC SUBSTANCES. VI. THE R_F-VALUES OF SEVERAL INORGANIC IONS IN PENTYL ALCOHOLS–HCl SOLVENTS. Nascutiu, T.; Iliescu, V. (Inst. for Atomic Physics, Bucharest). Rev. Roum. Chim., 12: 853-9(July 1967).

The R_F-values of 60 inorganic ions were determined by using the ascending developing technique on Whatman No. 1 chromatographic paper and 1 : 1 mixtures of n-pentyl alcohol–HCl, isopentyl alcohol–HCl and t-pentyl alcohol–HCl, the hydrochloric acid concentration extending from 1 to $10\underline{N}$. The R_F-values are listed both in order of the atomic numbers of the studied ions and their distribution along the chromatogram. (auth)

16676 SOLVENT EXTRACTION CHEMISTRY OF METALS. Proceedings of the International Conference, Harwell, Eng., 27–30 September 1965. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966. 456p. (CONF-650918).

The conference included 25 papers. Separate abstracts were prepared for 18 papers. The remaining 7 papers were previously abstracted for NSA and appeared as 19: 40645, 40646, 44115, 46423, 46430, 46431, and 46432. (UK)

For abstracts of individual papers see: 16677–16694.

16677 FACTORS INFLUENCING THE VARIABILITY OF RUTHENIUM DECONTAMINATION IN TBP PROCESSES. Fletcher, J. M.; Scargill, D. (Atomic Energy Research Establishment, Harwell, Eng.). pp 27-40 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

Ruthenium decontamination factors in TBP extraction systems have varied from <10 to about 10^4. Examples of low, moderate, and high values of DF_{Ru} are given and discussed. The progress made in the characterization of extractable nitrosylruthenium nitrato complexes in aqueous and TBP phases enabled some of the causes for the variability in DF_{Ru} to be understood. Some examples, based on the partition coefficients and equilibria of the extractable complexes, are given for the composition of ruthenium to be expected in certain organic phases. (auth) (UK)

16678 FISSION PRODUCT BEHAVIOR IN THE FIRST CONTACTOR OF A TBP PROCESS. Duncan, A.; Naylor, A.; Warner, B. F. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 3-26 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

The behaviour of ruthenium, zirconium, and niobium in the primary separation contactor of a 20% TBP in Odourless Kerosene (OK) process is discussed, and the effects of process variables on decontamination factors are outlined. Batch solvent extraction and paper chromatography were used to analyze the fission products into groups of species of differing extraction behaviour. It was concluded that at least three groups of ruthenium and zirconium–niobium species are present, and the limit to the scrub decontamination appears to be set by the properties of one group in each case. (auth) (UK)

16679 FATE OF FISSION PRODUCT ZIRCONIUM AND NIOBIUM IN THE DOUNREAY FAST REACTOR CHEMICAL REPROCESSING PLANT. Wallace, I. G. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 41-6 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

At the high activity levels experienced in the Dounreay Fast Reactor Chemical Reprocessing Plant zirconium is largely removed in the extractor and scrub of the first TBP cycle, but niobium tends to accompany the solvent, where it is mostly retained during backwashing. Under these conditions the theoretical relationship between DF_{Zr+Nb} in the first cycle, and the residual activity of the feed solvent, breaks down. (auth) (UK)

16680 UTILIZATION OF URANIUM(IV) NITRATE IN A SECOND CYCLE OF PURIFICATION OF PLUTONIUM BY TBP. Talmont, X. L. R. pp 103-16 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

The use of uranium(IV) nitrate stabilized by hydrazine to reduce plutonium has the advantage of introducing neither anions nor cations that might limit the possibility of concentrating the process effluents. This reducing agent was successfully tested on the plant scale for separating uranium and plutonium. Its use was also envisaged in a second cycle of decontamination of plutonium by 30% TBP in hydrogenated propylene tetramer. The use of uranium(IV) nitrate is delicate on account of its instability in the organic phase. This instability is greater in the presence of plutonium. Other factors that influence the stability of uranium(IV) are the free acidity, the concentration of nitrous acid, the surface area of the organic phase, time of contact with air, and residence time in the extraction apparatus. Suitable operating conditions were determined for process flowsheet using uranium(IV) nitrate. By using a pulse column the consumption of uranium(IV) can be reduced to less than twice the stoichiometric quantity. By this procedure a solution containing 25 g/l of plutonium was obtained. By feeding back a part of the backwashing product solution it is possible to obtain a plutonium solution of constant concentration, whatever the concentration of this element after the first cycle. In the absence of feedback a concentration factor of 10 was obtained during the backwashing. The residual contamination (mainly zirconium/niobium) of the plutonium is sufficiently low to render a further stage of decontamination unnecessary. There was less than 5 μCi of zirconium/niobium per gram of plutonium, even when the solvent employed had already been used in the first cycle of decontamination. (auth) (UK)

16681 URANIUM(IV) AS A PROCESS REDUCTANT FOR PLUTONIUM(IV). Baxter, W.; Naylor, A. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 117-32 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

Preliminary countercurrent trials on a miniature mixer-settler, using uranium(IV) as reductant, gave good separation of uranium and plutonium but, nevertheless, contamination of the uranium stream by plutonium was greater than expected and higher than with ferrous sulphamate. Single stage experiments with mixed phases showed that the low DF_{Pu} on the uranium stream was the result of slow reduction due to the combination of high acidity with low uranium(IV) concentrations. Optimum conditions for efficient reduction were calculated from these results and a revised flowsheet prepared. A trial of this flowsheet gave acceptable values of $DF_{Pu} = 1.4 \times 10^4$ and $DF_U = 3.5 \times 10^6$ across the contactor, demonstrating that uranium(IV) can be successfully used as an alternative reductant to ferrous sulphamate. (auth) (UK)

16682 THE ROLE OF NITROUS ACID IN THE REDUCTION OF PLUTONIUM(IV) BY URANIUM(IV) IN TBP SYSTEMS. Biddle, P.; McKay, H. A. C.; Miles, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 133-60 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

A rotating platinum microelectrode enabled plutonium(III) or plutonium(IV) to be determined polarographically, in either an aqueous or a TBP-diluent phase, at very low levels ($6 \times 10^{-6}\underline{M}$ in aqueous phases, $10^{-4}\underline{M}$ in organic). It was also used to make rough measurements on the concentration of stabilizers in organic phases. The rate of reduction of plutonium(IV) by uranium (IV) in organic phases was measured at 0 and 11°C, and an expression derived for the overall rate in a mixed phase system in terms of the rate in each phase. The rate of reduction in such systems containing nitric acid depends also on the autocatalytic rate of reaction of plutonium(III) with nitrous acid, and on the rate of reaction of nitrous acid with stabilizers. Both of these rates were measured in the organic phase. (auth) (UK)

16683 INFLUENCE OF HIGH RADIATION LEVELS ON THE RETENTION OF RUTHENIUM IN PROCESSING SOLVENTS. Kennedy, J.; Peckett, J. W. A.; Fletcher, J. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 187-96 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

The fraction of ruthenium removed from solvent phases by washing with sodium carbonate at 60°C for various lengths of time was used to assess the presence of solvent-retentive ruthenium complexes. Three types of ruthenium complexes were recognized in TBP phases by this procedure. The first, correlated with nitrato complexes of nitrosylruthenium, is rapidly removed; the second, correlated with nitrosylruthenium complexes of DBP and MBP is responsive to washing for times of a few hours; in the third, correlated with nitrosylruthenium or other ruthenium complexes with diluent degradation products, the ruthenium is so strongly bound that even prolonged washing effects little removal. Quantitative results for the fractions of the total ruthenium present as these three types in certain TBP phases are given. The slowness of ruthenium removal is in contrast to the fast removal of similar zirconium complexes, and accounts for the differences between the behaviour of the two elements found in solvent washing systems. The irradiation of Butex phases containing ruthenium also produces some ruthenium complexes that are only slowly removed by alkaline washing at 60°C. (auth) (UK)

16684 CHEMICAL DEGRADATION OF AROMATIC DILUENTS EXPOSED TO NITRIC ACID ATTACK. Baroncelli, F.; Grossi, G. (CNEN, Rome). pp 197-212 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

A study was made of the behaviour under the action of nitric acid, of Solvesso 100, a commercial mixture of aromatic hydrocarbons, in view of its possible use as a diluent in the aqueous reprocessing of irradiated reactor fuels. It was noted that the action of nitric acid on Solvesso 100 causes a high retention of ^{95}Zr. Solvesso 100 was subjected to gas-chromatographic analysis, and its major components identified and measured. The resistance of each individual aromatic hydrocarbon to chemical attack was tested, and on the basis of the results obtained it was possible to correlate the capacity to supply degradation products that retain zirconium in the organic phase with the position of alkyl substituents in the aromatic ring. (auth) (UK)

16685 MECHANISM OF EXTRACTION OF TRANSPLUTONIUM ELEMENTS BY TRILAURYLAMINE HYDROCHLORIDE. Muller, W.; Duyckaerts, G.; Fuger, J. (Univ., Liege). pp 233-46 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

In an attempt to gain an understanding of factors affecting the extraction of transplutonium elements by tertiary amines, the equilibria between hydrogen chloride and organic solutions of TLA were studied, and the amine extraction of ferric chloride in macro and tracer amounts was compared with the extraction of trivalent actinides and lanthanides. Complexes containing two molecules of amine salt per atom of the metal are formed when trivalent actinides and lanthanides are extracted from concentrated chloride solutions, or when trivalent iron is extracted from dilute hydrochloric acid or lithium chloride solutions; a 1:1 complex is observed for the extraction of ferric chloride from concentrated hydrochloric acid or chloride solutions. The 2:1 complexes are assumed to result from association of a 1:1 complex with a molecule of amine hydrochloride. The decrease in metal extraction at high chloride concentration, and with increasing acid activity, is due to competition between the extraction of the metal and the extraction of excess hydrogen chloride, the latter leading to amine dihydrochloride. (auth) (UK)

16686 REPROCESSING BY QUATERNARY AMMONIUM NITRATES: LABORATORY STUDIES. Koch, G. (Kernforschungszentrum Karlsruhe, Ger.). pp 247-66 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

Recovery of uranium and plutonium is possible by extraction with long-chain quaternary ammonium nitrates from aqueous nitric acid. Tricaprylmethylammonium (TCMA) nitrate, which is the nitrate form of Aliquat 336, in aromatic diluents (especially Solvesso 100), was studied as an extracting agent, and shows promising results. The extraction behaviour of uranium, plutonium, thorium, fission products, and nitric acid is reported. (auth) (UK)

16687 EXTRACTION OF PLUTONIUM WITH SOME MIXED EXTRACTANTS. Kraak, W.; Bac, R. (Institutt for Atomenergi, Kjeller, Norway). pp 267-74 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

Investigations on the extraction of plutonium by mixtures of amines and long-chain quaternary ammonium compounds, and by mixtures of various long-chain quaternary ammonium compounds, are described. The advantages of these mixtures over single compounds are outlined for both the extraction and backwashing of plutonium. Extractions with mixtures of TBP and amines are mentioned, and the possible advantages of these systems for obtaining a higher decontamination factor for both uranium and plutonium in a first extraction cycle are outlined. (auth) (UK)

16688 BACKWASHING, CONCENTRATION, AND DECONTAMINATION ON A SILICA GEL COLUMN OF PLUTONIUM EXTRACTED BY TRILAURYLAMINE. Hultgren, A. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 275-94 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

The use of a silica gel column for the transfer of plutonium from a TLA solution back to an aqueous phase is described. An aqueous solution containing a complexing agent, and perhaps a reducing agent, is passed through the column, the excess aqueous solution is expelled with inactive TLA solution, and the TLA solution containing plutonium is passed through the column. Experimental results are described for laboratory work employing media such as sulphuric acid, acetic acid, oxalic acid, and salts of these acids. The sulphate system was found most advantageous. Capacities greater than 500 bed volumes of solution at 0.1% breakthrough of plutonium may be reached with a sulphate-loaded stationary phase and with concentrations of plutonium in the mg/l range in the feed. Plutonium loadings higher than 30 g/l of bed volume, with a 0.1% loss of plutonium, were attained with concentrations of plutonium in the g/l range in TLA. Results from pilot plant runs on 400 MWd/ton fuel are also presented. Most of the uranium and fission products extracted pass through the silica gel column, yielding a further purification of plutonium in this step. As negligible amounts of sulphate are extracted, direct recycling of the amine is feasible, with only intermittent washing to limit build-up of solvent activity. (auth) (UK)

16689 USE OF NITROUS ACID AS A BACKWASHING AGENT FOR ACTINIDE-BEARING SOLVENTS. Bathellier, A. pp 295-304 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

Nitrous acid generated by reducing a dilute nitric acid solution with nitric oxide can be used to backwash actinide nitrates from TBP or trilaurylamine nitrate (TLAHNO$_3$) dissolved in dodecane. The extraction of nitrous acid by these organic solutions was studied. Consideration of the redox system HNO$_2$/NO$_3^-$ led to the conclusion that plutonium(IV) can be reduced to plutonium(III) by nitric oxide or nitrous acid at low acidity. An example of a countercurrent experiment involving TLAHNO$_3$ in dodecane loaded with plutonium, and 0.04$\underline{M}$ nitric acid, is described. Plutonium is backwashed into the aqueous phase with a yield of 99.8%. (auth)

16690 CONSIDERATIONS IN SOLVENT EXTRACTION PROCESSING OF U.S. BERYLLIUM ORES. Rosenbaum, J. B.; Dannenberg, R. O.; George, D'Arcy R. (Bureau of Mines, Washington, D. C.). pp 315-26 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

Laboratory studies on the selection and adjustment of parameters for organophosphate solvent extraction of beryllium from leach liquors of widely varying beryllium concentration are described. Feed solutions from the sulphuric acid leaching of various ores, differ markedly in beryllium concentration, with a consequent variation in the ratio of beryllium to other components, such as chloride, fluoride, magnesium, aluminum, iron, zinc, and manganese. Operating parameters and peripheral procedures for rejecting various contaminating elements are described. Modifications required to attain high beryllium extraction from 1$\underline{M}$ beryllium sulphate solutions, as opposed to 0.1$\underline{M}$ solutions, are also described. Application of the results of preliminary investigations to countercurrent extraction was shown to result in 98% extraction of the beryllium as a product that assayed over 98% BeO. (auth) (UK)

16691 SEPARATION OF ALKALI METALS BY SOLVENT EXTRACTION WITH MIXTURES OF ORGANIC-SOLUBLE ACIDS AND PHENOLS. Keder, W. E.; Martin, E. C.; Bray, L. A. (Battelle-Northwest, Richland, Wash.). pp 343-58 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

Alkali metal ions can be separated by extraction with di-(2-ethylhexyl) phosphoric acid (HDEHP) in hydrocarbon solutions. The order of extractability is $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$. Addition of 4-sec-butyl-2(α-methylbenzyl)phenol reverses this extractability order. Physical chemical studies on the molecular species involved in this extraction are discussed, the reasons for the extractability order are postulated, and some experiments are described concerning the effect of modification of the phenol molecule. (auth) (UK)

16692 CARBOXYLIC ACIDS AS REAGENTS FOR THE SOLVENT EXTRACTION OF METALS. Fletcher, A. W.; Flett, D. S. (Warren Spring Lab., Stevenage, Eng.). pp 359-76 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

The use of carboxylic acids as solvent extraction reagents is reviewed, and it is shown that they have the advantages of availability, relatively low cost, and widespread application to many metal ions in solution. The extraction equilibria are discussed, and it is shown how separations may be obtained by control of pH during extraction or by exchange extraction, whereby a metal in the organic phase is replaced by a more acidic metal ion in the aqueous phase. Extraction and backwashing rates are somewhat slower than those obtained with some reagents but are not prohibitive. The major factor in process costs is the amount of alkali or acid for extraction and backwashing, and not the solvent loss. (auth) (UK)

16693 CHEMISTRY OF THE FORMATION AND ELIMINATION OF A THIRD PHASE IN ORGANOPHOSPHORUS AND AMINE EXTRACTION SYSTEMS. Kertes, A. S. (Hebrew Univ., Jerusalem). pp 377-400 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

The data concerning the formation of a third phase are critically reviewed. The composition and the nature of the third phase, and the factors accounting for its formation, are discussed separately for three main extraction systems involving: (a) neutral organophosphorus compounds (extraction by solvation), (b) acidic organophosphorus compounds (extraction by compound formation), and (c) long-chain aliphatic amines (extraction by ion-association). Data on the solubility of metal salts in an aqueous electrolyte saturated with a ternary organic mixture composed of an extractant, a nonpolar diluent and a polar modifier are compared with the extractive power of the same organic mixture. While metal salts show increased solubility with increasing fraction of the polar component in the mixture, the extractability of the salts is markedly lower than in the absence of the modifier. The apparent contradiction between the antisynergistic effect of the polar modifier on extractability and its synergistic effect on solubility is discussed. Evidence is presented that is believed to show that the added modifier becomes an important constituent of the extracted complex in all extraction systems, regardless of the type of the organic phase species. The action of the modifier, however, is different in different extraction systems. While in systems where extraction takes place through solvation or compound formation the solubilizing power is due to a secondary solvation of the surface, in the case of amine extraction the solubilizer penetrates the interior of the complex, by forming solvent-separated ion pairs. Since modifiers alter the equilibrium state towards which an extraction system tends, and its technical value is to be judged by how far this alteration is favourable to the desired technical effect, more selective modifiers should be found which do not act anti-synergistically. (auth) (UK)

16694 APPLICATIONS OF SOLVENT EXTRACTION TECHNIQUES TO THE LARGE-SCALE RECOVERY AND PURIFICATION OF FISSION PRODUCT ELEMENTS. Moore, R. L.; Bray, L. A.; Roberts, F. P. (Battelle-Northwest, Richland, Wash.). pp 401-22 of Solvent Extraction Chemistry of Metals. McKay, H. A. C.; Healy, T. V.; Jenkins, I. L.; Naylor, A. (eds.). London, Macmillan, 1966.

From International Conference on the Chemistry of the Solvent Extraction of Metals, Harwell, Eng. See CONF-650918.

The objective of the work described was two-fold: to simplify waste storage by removal of long-lived heat generating isotopes and to provide highly purified fission products for sale. Scope of the work included extensive basic and applied laboratory research, hot-cell testing, engineering development, and plant application. Di-(2-ethylhexyl) phosphoric acid (HDEHP) extraction was extensively studied, and is being used for megacurie-scale production of highly purified ^{90}Sr. HDEHP processes were also developed and successfully applied for rare earth recovery, and for the separation of cerium from the trivalent rare earths. Use of dipicrylamine and phenol type extractants for cesium was also intensively studied, and a unique synergistic effect of phenols on HDEHP discovered, which makes possible simultaneous extraction of cesium, strontium, and rare earths. Effect of chemical variables, unexpected phenomena encountered, and comparative chemical and radiation stability of the solvents used in the above processes are discussed. (auth) (UK)

16695 IRRADIATED FUEL REPROCESSING. Alter, H. W.; Anderson, C. R. (to General Electric Co.). Canadian Patent 772,079. Nov. 21, 1967.

Procedures for reprocessing slightly enriched uranium fuel are described. The steps consist of dissolving irradiated reactor fuel in nitric acid, contacting the solution with an anion exchange resin to separate Pu from U and most of the fission products, fluorination and fractionation of volatile fluorides to separate U from the fission products. UF_6 is amenable to direct reintroduction into U enrichment facilities. Pu is eluted from the anion exchange resin and after a second pass over another resin column is obtained as fully decontamined Pu product solution. Fewer processing steps, reduced volume of radioactive waste solution, and less capital equipment are claimed as advantages over former processes. (F.S.A.)

16696 PROCESS OF DEUTERIUM ENRICHMENT BY THE AMMONIA-HYDROGEN EXCHANGE SYSTEM USING POTASSIUM AMIDE AS CATALYST. Walter, S.; Schindewolf, U. (to Friedrich Uhde GmbH). Canadian Patent 773,480. Dec. 12, 1967. Priority date June 23, 1964, Germany.

To avoid blockage in the hot and cold towers in the ammonia–hydrogen exchange process, the feed gases must be free of oxygen-containing impurities. Prior to contact in the presence of the potassium amide catalyst, the hydrogen or hydrogen–nitrogen mixture is freed of water by contact with a molecular sieve or liquid ammonia. After this, the gases are passed through a purification tower containing sodium amide dissolved in ammonia to remove oxides of carbon. (F.S.A.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 16415, 16632, 16639, 16773, 16792, and 16795–16825.

16697 (COO-1281-9) ANALYSIS OF TRACE ELEMENTS AND OF RADIOACTIVE BACKGROUNDS IN LAKES. Final Technical Report. Wall, John Peter (Wisconsin Univ., Madison. Lab. of Limnology). Dec. 1967. Contract AT(11-1)-1281. 7p. Dep. CFSTI.

A reliable bioassay technique was developed for measuring the concentration and distribution of vitamin B_{12} in fresh water. A large number of samples from Wisconsin Lakes were assayed for vitamin 12. Atomic Absorption Spectrometry (AAS) shows promise for the determination of major ions in natural waters. The pattern of background radiation counts was observed to be higher at the periphery of lakes rather than at the center. The amount of radiation is related to the type of bottom strata with muds and clays retaining more radioactivity than sand and gravel. (F.S.)

16698 (SC-RR-67-861) MODEL FOR ESTIMATING THE DISTRIBUTION OF CATIONS IN MULTICOMPONENT ION EXCHANGE REACTIONS. Sallach, R. A. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. 22p. Dep. CFSTI.

The model developed by Langmuir for the adsorption of gases on solids was adapted and applied to cation-exchange phenomena. The relationship between the amount exchanged on the surface and its concentration in solution is expressed in terms of mass-action-type equilibrium constants. After considering all possible exchange reactions and their mutual effects, an analytic expression was deduced describing the experimentally defined distribution coefficient in terms of the equilibrium constants and concentrations of the various cations, and of the cation-exchange capacity of the mineral. Good qualitative agreement with experimental results was found for those minerals in which exchange is truly a surface phenomenon. Quantitative comparisons are difficult because a reference ion common to all experiments is lacking. (auth)

16699 MEASUREMENT OF SNOW-WATER RESERVES USING NATURAL SOIL RADIOACTIVITY. Gerrard, Martha. Isotop. Radiat. Technol., 5: 212-13(Spring 1968).

The results of preliminary tests indicate that under some conditions it may be feasible to measure snow-water reserves by determining the degree to which the snow cover attenuates the natural soil radioactivity. The method is described. (auth)

16700 PURIFICATION OF WATER AFTER DECONTAMINATION BY FILTRATION IN SOIL. Boyer, Jean; Cook, Bernard (Centre de Recherches et d'Experimentation de Genie Rural, Antony, France). Prot. Civ. Secur. Ind., No. 157, 39-44(Sept. 1967). (In French).

After decontamination of water by filtration in soil, the water is often muddy, has a yellow coloration, and is probably bacteriologically impure. Wood charcoal, aluminum sulfate, ferrous sulfate, potassium permanganate, and a combination of potassium permangnate and sodium hypersulfite were tested to determine their efficiency for the decoloration of the water and the elimination of the mud. Wood charcoal gave the best results, although the mixture of the potassium permanganate and sodium hypersulfite gave usable results. The combination of filtration on wood charcoal and of the addition of mixtures of potassium permanganate and sodium hypersulfite assured the bacteriological purity of the water. The water obtained after this treatment was clear with no disagreeable taste or odor and was easily digested. (J.S.R.)

16701 RADIOGEOLOGIC STUDIES IN THE CENTRAL PART OF THE SIERRA NEVADA BATHOLITH, CALIFORNIA. Wollenberg, Harold A.; Smith, Alan R. (Univ. of California, Berkeley). J. Geophys. Res., 73: 1481-95(Feb. 15, 1968).

Radioactivity in granitic rocks of the central Sierra Nevada varies both regionally and with rock type. It is lowest in the western foothills and increases eastward to the crest of the range. East of the crest radioactivity is generally lower than in the crestal region, but south of Big Pine Creek it increases eastward from low values in the Inconsolable granodiorite to high values (similar to those along the Sierra crest) in the Tinemaha granodiorite of the Poverty Hills. Within any given area radioactivity varies with silica and the alkalis; it is lowest in diorite and gabbro and progressively higher in quartz diorite, granodiorite, and quartz monzonite. On the west slope of the Sierra Nevada, the isotopic ages of the rocks increase westward, opposite to the direction of increase of radioactivity. This relation and preliminary heat flow values (which indicate a westward decrease in heat flow) are consistent with the concept of a vertically fractionated batholith in which the heat sources were concentrated in the upper parts. According to this concept, the oldest rocks have the lowest heat production because they have been eroded to the deepest levels. This concept fits less well with the relations east of the crest, where the isotopic ages of the granitic rocks are even older than those in the western foothills. The picture may be complicated by an original inhomogeneous distribution of the radioactive minerals in the source rocks from which the granitic magmas were derived. The proportions of U, Th, and K are generally constant within any given pluton and in plutons that are compositionally similar and of the same age, but they may be significantly different in plutons that are compositionally and temporally unrelated. Different proportions of the radioactive elements in three pairs of plutons that had been correlated on the basis of petrographic similarity suggested faulty correlations. Recent geologic work and isotopic age dating have shown that the correlations were incorrect in two of the cases. A limited study in fission-track autoradiography suggests the U is mainly contained in biotite in rocks rich in biotite and in the non-magnetic accessory minerals in rocks that contain little or no biotite. (auth)

16702 TRIAXIAL COMPRESSION DATA ON NUCLEAR EXPLOSION SHOCKED, MECHANICALLY SHOCKED, AND NORMAL GRANODIORITE FROM THE NEVADA TEST SITE. Giardini, A. A.; Lakner, J. F.; Stephens, D. R.; Stromberg, H. D. (Univ. of California, Livermore). J. Geophys. Res., 73: 1305-20(Feb. 15, 1968).

Compression tests were performed at room temperature on solid circular cylinders of medium-grained granodiorite from the Hardhat Event conducted at the Nevada Test Site. Confining pressures ranged from 1 to 7000 bars. A piston-cylinder apparatus equipped with an internal axial load cell and manganin coil was used. The confining fluid was a low-viscosity oil. Predetonation specimens were cut 0°, 45°, and 90° to the drill core axis and were taken from 195-, 225-, and 255-meter depths. Post-detonation rock was sampled at 23 and 27.5 meters from ground zero, which was located at a depth of 290 meters and experienced a calculated peak shock pressure of approximately 20 kb. Specimens mechanically shocked in the laboratory (35 to 40 kb) were from the 195-meter depth pre-detonation sample. No orientational effects were observed. The failure of granodiorite under compressional stresses was found to be adequately described by a modified Coulomb maximum shear stress theory. Under uniaxial compression, the mode of failure was brittle shear. Under triaxial compression, a quiet slip failure was observed at low confining pressures and brittle shear at high confining pressures. A possible explanation for the occurrence of slip failure may be the presence of a fluid pore pressure within the specimen. Strain measurements were made on several specimens. At atmospheric pressure, the stress histories of the rock were clearly apparent. Under confining pressure, shock effects rapidly disappeared, and, at 4.5 kb, the behavior was essentially that of normal granodiorite. Young's modulus at atmospheric confining pressure for unshocked rock was found to be $0.64 \pm 0.26 \times 10^6$ bars, which in the upper limit agrees with the reported dynamic value. The average value for rock shocked by nuclear blast is 0.18×10^6 bars and that for mechanically shocked rock is of the order 0.01×10^6 bars. (auth)

16703 GEOLOGICAL SURVEY RESEARCH, 1967. CHAPTER A. Geological Survey Professional Paper 575-A. Washington, D. C., U. S. Government Printing Office, 1967. 387p. GPO $2.25. (NP-17253).

A summary of scientific and economic results of the investigations of mineral resources, water resources, and management of natural resources on public lands is given. Geology and hydrology applied to engineering and public health are outlined. Regional geology in the United States is summarized and geology and hydrologic investigations in other countries are included. Principles and processes of geology are given. A list of publications for 1967 is included. (J.C.W.)

Meteorology

Refer also to abstracts 16459 and 18660.

16704 (A/AC-82/G/L-1159) FALLOUT SITUATION IN DENMARK, FINLAND, NORWAY, AND SWEDEN IN 1965–1966. (United Nations Scientific Committee on the Effects of Atomic Radiation). Oct. 2, 1967. 25p. Dep.

The occurrence of the long-lived fallout nuclides strontium-90 and cesium-137 in the Scandinavian countries is reported in milk and meat and total diet. Measurements of Sr-90 and Cs-137 in sea water are reported. Sr-90 in human bone and Cs-137 in human muscle measurements are presented. Ce-144, Mn-54, Ru-106, and Sb-125 were reported in air and precipitation. Mn-54 and Fe-55 were found in foodstuffs, and Fe-55 was reported in human blood. (J.C.W.)

16705 (BNWL-SA-1452-A) HANFORD EXPERIENCE WITH COMPOSITE ENVIRONMENTAL DOSE ESTIMATES. Corley, J. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 8, 1968. Contract AT(45-1)-1830. 19p. (CONF-680108-2). Dep. CFSTI.

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga.

Annual environmental dose estimates have been reported. Evaluations of environmental conditions based on combined percentages have been replaced by dose estimates for specific body organs for selected population groups and is recommended. Specific questions answered for dose estimation are reviewed. The dose calculation for consumers of Columbia River fish required identification of the numbers of fish eaten, and the species and locations in which taken. Resolution required creel surveys, questionnaires, and whole body counting. The effort to pursue the dose estimate portion of the environmental surveillance program is described. (J.C.W.)

16706 (EUR-3884) SORVEGLIANZA DEL SITO ALL'INTERNO DEL C.C.R. EURATOM ISPRA. (Site Surveillance within EURATOM JRC at Ispra. De Bortoli, M.; Gaglione, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Dec. 6, 1967. 38p. (In Italian). Dep.

The results of the site survey measurements performed within the fence of the Ispra Establishment during 1966 and 1965 are reported and briefly discussed. It may be concluded that most of the contamination found on the site is due to the world-wide fallout. (auth)

16707 (KFK-646) DIE AUSBREITUNG DER RADIOAKTIVEN WOLKE UND DIE ZU ERWARTENDEN INHALATIONSDOSEN. (The Spreading of the Radioactive Cloud and the Inhalation Dose to be Expected). Bayer, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Sept. 1967. 37p. (In German). Dep.

The formulas used for the description of the spreading of a radioactive cloud and the pertinent parameters were discussed. For chimney heights of 0, 50, and 100 m, the propagation factors resulting were given for source distances up to 100 km. The results obtained were compared and a conservative estimation of the propagation factors was proposed, which can serve as standard propagation factors. With the help of the discharge danger occurring for a given maximum credible accident, the iodine inhalation dose was determined by application of this conservative estimation. A guide for the meteorological neutral evaluation of the individual burden in an accident was given. (tr-auth)

16708 (KFK-653) MUNDO: DIGITAL PROGRAMM ZUR BERECHNUNG VON UNFALLDOSEN IN DER UMGEBUNG EINER REAKTORANLAGE. (MUNDO: Digital Program for Calculation of the Accidental Dose in the Neighborhood of a Reactor Site). Heller, F.; Schikarski, W.; Wickenhaeuser, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut Angewandte Reaktorphysik). Sept. 1967. 34p. (In German). (EUR-3684). Dep.

The digital program MUNDO (maximum accidental dose) calculated the dose equivalent in rem received at the site $\vec{r}$ at time t as a function of the physical relation between the accident pattern considered and the release of radioactive materials from the reactor core, the transport processes, decontamination behavior, deposition behavior, and filtration behavior of the radioactive materials released in the accident, the leakage of the radioactive material present in the reactor building through the containment system, the distribution and propagation of the radioactive material released as a function of the weather conditions, and the application of the accidental dose to one site in the neighborhood of the reactor installation. The program calculates the contribution of about 80 fission products and fuel element isotopes to the accidental dose. A general description is given of the physical relations. The mathematical model is described, and the construction of the FORTRAN program was given. (J.S.R.)

16709 (NP-17268) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND AND RESULTS OF EXTENDED MONITORING OF FALLOUT FROM FRENCH NUCLEAR TESTS IN THE PACIFIC. Quarterly Report, July-September 1967. (National Radiation Lab., Christchurch (New Zealand)). 22p. (NRL-F-26). Dep.

Locations of the collection stations are named for New Zealand and the Pacific Area. The results of the extended monitoring of fallout from the French nuclear tests in the Pacific are given. Three nuclear devices were exploded at Mururoa and the levels of radioactivity due to long-lived and short-lived radionuclides are tabulated. (J.C.W.)

16710 EVOLUTION OF CONDENSATION NUCLEI FORMED BY RADIOLYSIS OF GASEOUS IMPURITIES OF AIR. **Billard, Francois; Bricard, Jean; Cabane, Michel; Madelaine, Guy (CEN, Fontenay-aux-Roses, France. Faculte des Sciences, Paris). Compt. Rend., Ser. A and B, 265: 1376-9(Dec. 18, 1967). (In French).**

The formation of condensation nuclei which appear in natural air previously freed of aerosols by filtration and to which thoron was added was studied. On study of evolution of these particles with respect to time, and their charge state, an important coagulation effect is shown. (tr-auth)

16711 TRACE GASES AND SUSPENDED MATTER IN THE AIR. **Israel, Hans (Technische Hochschule, Aachen). Naturwiss. Rundsch., 20: 329-36(Aug. 1967). (In German).**

The concentrations and origins of trace gases and suspended matter in the air are briefly reviewed. The propagation of aerosols and their residence time in the atmosphere are described. (J.S.R.)

16712 URBAN-RURAL CLIMATOLOGY OF ATMOSPHERIC RADON CONCENTRTIONS. **Hosler, Charles R. (Air Resources Lab., Silver Spring, Md.). J. Geophys. Res., 73: 1155-66(Feb. 15, 1968).**

Atmospheric concentrations of radon, calculated from filtered radon daughter β-activity and corrected for radioactive equilibrium departure, were obtained from three sites in the Washington, D. C., area. Measurements made at various heights above ground up to 91 meters yield diurnal, seasonal, and annual mean radioactivity concentrations and their relationship to meteorological variables. These data indicate that the horizontal distribution of radon is homogeneous during much of the midday period. Radon measurements over a distance of about 40 km suggest that the urban area does not act effectively as either a source or sink for radon. On the basis of derived atom concentration ratios ($\rho = {}^{214}\text{Bi}/{}^{214}\text{Pb}$), radon is near secular equilibrium with its daughter products in the air; the major departure from equilibrium occurs during atmospheric stability and near the ground. Analyses of the temporal-spatial variations of atmospheric radioactivity indicate that the variation in the concentration of radon at a given height above the ground is mostly a consequence of atmospheric dilution, specifically, vertical mixing; the effects of advection, changes in emanation rates, and various scavenging processes are slight (except for relatively short time-space dimensions) relative to the effects of vertical mixing. (auth)

16713 TRITIUM AND DEUTERIUM IN ATMOSPHERIC METHANE. **Begemann, Friedrich (Max-Planck Institut fuer Chemie, Mainz); Friedman, Irving. J. Geophys. Res., 73: 1149-53(Feb. 15, 1968).**

Ten samples of atmospheric methane collected at Oberhausen, Germany, and Gary, Indiana, between 1960 and 1963 were analyzed for their tritium and deuterium content. The results show the tritium concentration in the northern hemisphere to have been essentially constant since 1958, the time the first samples were analyzed. Existing theories to explain the origin of tritiated methane are discussed and rejected as highly improbable. The data can best be explained by assuming that leakage of tritiated methane into the atmosphere from sources in nuclear industry located in the northern hemisphere occurred for a period of years prior to 1958, and then the leak was essentially closed. (auth)

16714 ISOTOPIC COMPOSITION OF ATMOSPHERIC HYDROGEN. **Begemann, Friedrich (Max-Planck Institut fuer Chemie, Mainz); Friedman, Irving. J. Geophys. Res., 73: 1139-47(Feb. 15, 1968).**

Thirty-two samples of atmospheric molecular hydrogen, collected at Oberhausen and München, Germany, between 1958 and 1963 were analyzed for their tritium and deuterium content. The procedure for extracting the hydrogen from the crude neon fraction from air liquefaction plants is described in detail. Data indicating good reproducibility are given. Where possible the results are compared with results obtained on the same samples in other laboratories. Reasons for discrepancies, which in some cases amount to 50%, are discussed. During the 1958 to 1961 test moratorium on thermonuclear weapons the tritium level continued to rise; yet, no immediate significant increase due to the large USSR test series at the end of 1961 has been observed. (auth)

16715 TRITIUM CONTENT OF ATMOSPHERIC METHANE AND ETHANE. **Haines, Alan; Musgrave, B. C. (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 73: 1167-73(Feb. 15, 1968).**

Samples of liquid oxygen collected at ground level near Neosho, Missouri, have been processed for recovery of methane, and the tritium content of these samples has been measured. The fluctuation of the T/H ratio in these samples is discussed in terms of possible sources of this radioactivity. Arguments that this tritium-labeled methane has been released from sources in nuclear industry are supported by measurements of tritium in ethane recovered from some of these liquid oxygen samples. The continuing release of labeled methane by nuclear industry is suggested by the fact that the T/H ratio has not changed appreciably during the period 1958 to 1966, although this interval is comparable to the chemical lifetime expected for methane in the atmosphere. (auth)

16716 RADIOCARBON FROM NUCLEAR WEAPONS TESTS. **Young, James A.; Fairhall, A. W. (Univ. of Washington, Seattle). J. Geophys. Res., 73: 1185-1200(Feb. 15, 1968). (RLO-1776-5).**

The distribution in time and space of ^{14}C from the 1961 to 1962 nuclear weapons tests of the U. S. and the USSR is used as a tracer for atmospheric mixing phenomena and exchange of carbon dioxide between the atmosphere and the sea. The mean residence time of ^{14}C injected into the stratosphere by the tests or produced by cosmic rays is about 1.5 years before entering the troposphere. The ^{14}C enters the troposphere predominantly at midlatitudes in the late spring. Dispersion of the ^{14}C injected into the troposphere is well accounted for by eddy diffusion, with the meridional eddy diffusion coefficients being proportional to the variance of the meridional component of the wind speed. Exchange of carbon dioxide between the atmosphere and the sea (and therefore uptake of excess ^{14}C by the sea) is taken to be proportional to the square of the average wind speed over the sea surface. This leads to the conclusion that the bulk of the ^{14}C will eventually be taken up by the oceans of the southern hemisphere. A mean residence time of 2.5 years for a carbon dioxide molecule in the troposphere before uptake by the sea is deduced from the model, giving a mean residence time of 4 years for a ^{14}C atom in the atmosphere before uptake by the sea. (auth)

16717 TRANSPORT OF SMALL PARTICLES TO VERTICAL SURFACES. Wells, A. C.; Chamberlain, A. C. (Atomic Energy Research Establishment, Harwell, Eng.). Brit. J. Appl. Phys., 18: 1793-9(Dec. 1967).

Radioactive particles were used to study deposition from airstreams on to vertical surfaces. Polystyrene spheres .5 μm in diameter, incorporating ^{51}Cr, tri-cresylphosphate droplets 2.1, 1.1, and 0.65 μm diameter with ^{32}P activity, and natural Aitken nuclei tagged with ThB (^{212}Pb) were used. The deposition on to smooth surfaces by impaction from turbulent flow was compared with theoretical predictions. Deposition by Brownian motion was also important for the smaller particles, and the results were in accordance with the empirical law relating transport to the two-thirds power of the diffusivity of the particle. When the deposition surface was covered with filter paper it remained aerodynamically smooth, but the deposition of particles was greatly increased since roughness elements too small to disturb the viscous boundary layer of the airflow are nevertheless effective in removing particles from it. (auth)

16718 DETECTION OF ^{125}Sb IN CRUDE LEAD. Kolb, W. (Physikalisch-Technische Bundesanstalt, Brunswick. Physikalisch-Technische Bundesanstalt, Berlin). Z. Naturforsch., 22A: 1816-18(Nov. 1967). (In German).

From scintillation spectrometer measurements it appears that certain kinds of recently produced lead may be contaminated with ^{125}Sb probably from atmospheric fallout. The activity concentration of ^{125}Sb in a crude lead sample made from ore concentrate of very low radioactivity was found to be 4 fCi/g. This low value was sufficient to produce additional photopeaks in the background spectrum of a low level scintillation counter if the material was used as the detector shielding. The ^{125}Sb concentration in lead containing a few percent of antimony will be even higher. For refined lead, however, the probability of contamination is rather low because ^{125}Sb is separated during antimony raffination in the lead smelter. (auth)

16719 RADIONUCLIDE FRACTIONATION IN FALLOUT PARTICLES FROM AN AIR BURST. **Mamuro, Tetsuo; Matsunami, Tadao; Fujita, Akira (Radiation Center of Osaka Prefecture). Health Phys., 14: 223-38(Mar. 1968).**

Radionuclide fractionation in individual highly radioactive fallout particles from the third Chinese nuclear explosion on 9 May, 1966 was investigated by γ-ray spectrometry. Activities of ten radionuclides, ^{95}Zr, ^{97}Zr, ^{99}Mo, ^{140}Ba, ^{141}Ce, ^{143}Ce, ^{144}Ce, ^{147}Nd, ^{237}U, and ^{239}Np, were measured and the initial atom numbers of these nuclides contained in each sample were estimated. In order to express the degree of fractionation, the fractionation factors defined with respect to ^{95}Zr were calculated for each sample. The experimental results obtained are discussed with regard to the following: (1) Relation between the initial atom number and the particle volume, (2) Relation between fractionation factors, (3) Fractionation in relation to the decay chains, (4) Estimation of the time-interval between detonation and formation of particles, and (5) Fractionation in relation to the chemical composition of the matrix materials. (auth)

16720 SIGNIFICANCE OF SYMMETRIC FISSION IN FALLOUT STUDIES FROM MAY 1966 CHINESE NUCLEAR EXPLOSION. Rao, M. N.; Mo, T.; Clark, R. S. (Univ. of Arkansas, Fayetteville). Health Phys., 14: 269-70(Mar. 1968).

Very little attention has been given to the radionuclides belonging to the symmetric fission region ("valley" region of mass-yield curves) for nuclear explosions. The yields of fission products in this region depend on the type of nuclear reaction e.g., (a) thermal neutron induced fission, (b) fission neutron induced fission, (c) 14 MeV neutron fission, and vary from one fissionable nuclide to another. Results of the analysis of debris from the third Chinese nuclear explosion are presented, and the importance of symmetric fission is discussed. (UK)

16721 DISPERSION OF FISSION PRODUCTS FROM LAMINAR STREAMS IN OPEN- AND CLOSED-LOOP CONDUITS. Venerus, E. R. (General Electric Co., Schenectady, N. Y.); Ozisik, M. N. Contract W-31-109-eng-52. Nucl. Sci. Eng., 31: 531-9(1968). (KAPL-P-3332).

Two simplified models which describe the deposition of fission products from laminar gas streams on the surface of a cylindrical conduit are formulated for both open- and closed-loop systems. A uniform source is assumed to release a precursor into a gas stream. Solutions are obtained for the deposition of the precursor and its associated daughter products. The boundary value problem consisting of two coupled partial differential equations for each nuclear species is analyzed for two models. The two models, which arise due to the imperfect sink condition at the tube surface for impinging particles, are termed "The Resistance Model" and "The Transport Model." Both models are approximate and the range of their validity is discussed. The closed-form solutions obtained with the two simplified models provide a good insight to the effects of various parameters on deposition of fission products in closed-loop systems and on the deposition of daughter products both in open- and closed-loop systems. (auth)

16722 ATMOSPHERIC ^{212}Bi: MEASUREMENT AND SOME GEOPHYSICAL APPLICATIONS. Gat, Joel R.; Assaf, Gad (Weizmann Inst. of Science, Rehovoth, Israel). Science, 159: 977-9(Mar. 1, 1968).

The concentrations of ^{212}Pb and its short-lived daughter ^{212}Bi in air near the ground were determined simultaneously by adaptation of the immersed-filter, delayed-coincidence technique of Assaf and Gat to measurement of the 3×10^{-7}-second ^{212}Bi and ^{212}Po pair. The radioactive disequilibrium between ^{212}Pb and ^{212}Bi depends strongly on the efficiency of the ground in acting as a sink for these nuclides. This efficiency is low under dry conditions. (auth)

Mineralogy and Exploration

16723 (RME-142) DOLLAR PROGRAM FOR CALCULATING URANIUM ORE RESERVES. Scott, James H. (Grand Junction Office (AEC), Colo. Production Evaluation Div.). July 1963. 28p. Dep. CFSTI.

The Atomic Energy Commission's DOLLAR program enables a digital computer to calculate ore reserves for underground uranium mines at various concentrate prices. In this program each mining level is divided into ore blocks; then the area of each ore block is determined and punched on IBM cards along with the block number, hole or channel number, and sample data from the hole or channel. The sample data may be gamma-ray log readings or assays of sample intervals in holes or channels. Control data cards also are keypunched, and these relate to property identification, minimum mining thickness, dilution grade, tonnage factor, direct operating costs, indirect costs, and a list of U_3O_8 prices for which block-by-block printout is needed. After keypunching, these sets of data cards and the DOLLAR program cards are submitted to the IBM 7090 computer center where the information on the cards is transferred to magnetic tape prior to computer analysis. In this analysis the DOLLAR program develops for each selected cut-off grade block tonnage, average grade, pounds U_3O_8 in ore, pounds U_3O_8 in concentrate, direct cost per pound U_3O_8, and total (direct plus indirect) cost per pound U_3O_8. Totals and averages for all blocks are printed following the block-by-block printout for each cut-off grade. If more than one level or property is run, a summary is printed to show totals and averages for all levels or properties. Data in the summaries also are plotted graphically to show how reserves are affected by changes in U_3O_8 prices.

Using the DOLLAR program the 7090 computer generates ore reserve information for underground uranium mines at a rate of about 60 holes (or channels) per minute for the thirteen different U_3O_8 prices from $4 to $16 per pound. After performing arithmetic and logical operations set forth by the program, the machine prepares magnetic tape containing output information that is printed off line. The methods of reserve computation in the DOLLAR program are comparable to hand methods that generally have been accepted as valid and reasonably accurate. (auth)

16724 (RME-144) PREPARATION OF GAMMA-RAY LOG DATA FOR IBM CARD PUNCHING. Young, Harry B.; DeVergie, Paul C. (Grand Junction Office (AEC), Colo. Mining Div.). Dec. 1963. 35p. Dep. CFSTI.

Data necessary for the U. S. Atomic Energy Commission's ore reserve calculations are obtained by punching pertinent information from gamma logs onto IBM cards, which are then processed by an IBM 7090 digital computer. The format for drill-hole data consists of a header card generally followed by one or more continuation cards. The header card is made up for each drill-hole log and contains information on the physical characteristics of a drill hole. Continuation cards contain a list of gamma-amplitude readings; they are used only if a log shows anomalous radioactivity. Data tabulation sheets are filled out for gamma-log header cards before keypunching. Two methods may be used to prepare and punch the readings on the continuation cards. In the hand-digitizing method the readings are manually scaled off, entered in specific columns on the data tabulation sheet, and finally keypunched along with data on the corresponding header cards. In the method using the Gerber chart reader, header cards are keypunched manually and subsequently utilized as a guide in digitizing the corresponding logs. This latter method of combined digitizing and automatic punching is faster and more accurate than the former method, but requires care and consistency in editing all the logs. (auth)

16725 CALCULATING THE WORLD'S URANIUM RESOURCES. Brinck, Johan (Euratom Supply Agency, Brussels). Euratom Bull., 6: 109-14(Dec. 1967).

A mathematical model is suggested for estimating the size of potential uranium ore reserves for any given grade of enrichment. Using this model uranium resources compared to foreseeable requirements show no shortage of uranium. Excessively high prices should not be expected from any natural insufficiency of resources, and the long term supply appears to be a politicoeconomic problem. (F.S.)

16726 CIVIL APPLICATIONS OF ATOMIC ENERGY PLACES NEW ACCENTS ON THE URANIUM INDUSTRY OF THE USA AND CANADA. Guenzel, H.; Knorr, B. Metall, 22: 73-6(Jan. 1968). (In German).

The principal mining developments in the United States and Canada are tabulated and their output is described. (J.S.R.)

16727 A STABLE URANIUM MARKET: A NECESSITY FOR THE DEVELOPMENT OF NUCLEAR ENERGY IN EUROPE. Roux, G. (Denison Mines Ltd., Paris). Metall, 22: 71-2(Jan. 1968). (In German).

The increasing demands made on the uranium supply are briefly indicated, and the construction of improved processing installations and the discovery of new ore deposits for the satisfaction of these demands are discussed. The factors leading to uncertainties in the evaluation of the future uranium supply are described. (J.S.R.)

Oceanography

Refer also to abstracts 16632, 16743, and 16746.

16728 (FRL-1) RADIOACTIVITY IN SURFACE AND COASTAL WATERS OF THE BRITISH ISLES. (Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Fisheries Radiobiological Lab.). Oct. 1967. 45p. Dep.

The United Kingdom has been a pace-setter in the use of nuclear energy and a principal exponent of environmental dispersion of low-level radioactive waste, including sea disposal. Most stringent standards should be set by which to ensure the complete safety of such discharges. The results of extensive monitoring programs and site-assessments are reported. (J.C.W.)

16729 MOVEMENT OF RADIOACTIVE MATERIAL FOR THE SHORE AND OFFSHORE RELEASE OF LOW LEVEL LIQUID WASTES. Sakagishi, Shokichi (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 13: No. 9, 32-35(Sept. 1966). (In Japanese).

In the operation of radioactive installations, such as atomic power stations and fuel reprocessing plants, although low in radioactivity, large amounts of liquid wastes are released into the sea. A study was made of how the radioactive material in the effluent was diffused and diluted by the sea water. For this purpose, an effluent was released at three points: 1 km offshore, at the beach, and at the mouth of a river. In the case of a continuous release and then diffusion, for the distances of several-tens m to 10 km, the concentration along the axis is approximately $C/Q = 0.75/X$, where C is the concentration at point X, Q is the release rate, and X is the distance. In connection with this formula, problems of experimental data scattering and diffusion close to the release point are discussed. The areal dispersion of an experimental, released dye is also analyzed. (NSA of Japan)

16730 DEUTERIUM CONTENT AS A PARAMETER OF WATER MASS IN THE OCEAN. Horibe, Yoshio; Ogura, Nobuko (Tokyo Univ.). J. Geophys. Res., 73: 1239-49(Feb. 15, 1968).

The deuterium content of ocean water was measured by mass spectrometry and a small modification for the preparation of hydrogen gas with uranium gave a reproducible result within ±0.2‰ of the δ value. It is shown that the deuterium content is a very useful parameter of ocean water. The deuterium content in ocean water is not necessarily proportional to salinity, and the deuterium-salinity diagram of one station at various depths is characteristic. The deuterium-salinity relation shows that fresh water or land water has an influence on ocean water down to a depth of 100 meters. Kuroshio is a large water mass of uniform deuterium content, reaching a depth of 500 meters. The heavy deuterium content of Kuroshio (+1.0‰, which is heavier by 1.5‰ than that of the surrounding bottom water) has an effect on the bottom water. The deuterium-salinity diagram of Kuroshio can easily be distinguished from the deuterium-salinity diagrams of other water masses. (auth)

16731 RADIOACTIVITIES IN DEEP-SEA SEDIMENTS AND POLAR SNOW. Science, 159: 939-40(Mar. 1, 1968).

Meteorites contain measurably anomalous amounts of radioactive and stable isotopes produced by corpuscular radiation in space or by more complex events during the meteorites' history. Besides using isotopes to identify meteorites, similar measurements can be used to identify interplanetary dust. Samples were collected from deep sea sediments and polar ice for analysis for extraterrestrial dust. The analyses of the sediments and ice for ^{26}Al, ^{10}Be, ^{35}Cl, ^{36}Cl, ^{60}Co, and ^{60}Fe to determine the presence of extraterrestrial dust is described. (F.S.)

ENGINEERING

Nuclear Explosions

Refer also to abstract 16702.

16732 (BM-RI-6996) FRACTURING A DEPOSIT WITH NUCLEAR EXPLOSIVES AND RECOVERING COPPER BY THE IN-SITU LEACHING METHOD. Hardwick, William R. (Bureau of Mines, Tucson, Ariz.). Dec. 1966. 51p. Dep. CFSTI.

It appears that copper deposits can be safely fractured with nuclear explosives and the copper successfully recovered by in situ leaching. The process has a high success potential and must be evaluated by a full-scale test before the economics or the extent of the use of the method by the mining industry can be predicted. Preliminary calculations indicate that the cost of fracturing copper deposits with nuclear explosives may range from 1.8 to 55.2 cents per ton. Copper may be recovered by this method at less cost than by conventional methods. (JCW)

16733 (ORNL-TM-2119) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, October 1–December 31, 1967. Arnold, W. D.; Blake, C. A. Jr.; Crouse, D. J. (Oak Ridge National Lab., Tenn.). Feb. 2, 1968. Contract W-7405-eng-26. 12p. Dep. CFSTI.

A column leaching test confirmed previous results which showed that most of the tritium (as tritiated water) would be washed readily from nuclear-broken copper ore. The tritium concentration of copper ore leach liquors containing radionuclides which interfere with direct liquid scintillation counting was accurately determined by distilling part of the sample and measuring the tritium concentration of the distillate. When tritium-contaminated shale oil was distilled, tritium was found in all of the distillate fractions. None of the tritium was removed from the crude oil by contacting it with solid drying agents or with water. (auth)

16734 TOTAL DEFENSE AND CIVIL PROTECTION IN NORWAY. Von Zitzewitz, Horst. Prot. Civ. Secur. Ind., No. 157, 17-24(Sept. 1967). (In French).

The concepts of total defense and civil protection as used in the Norwegian defense plans are defined. The civil protection in Norway is described within the frame work of the total defense of Norway and Denmark. The obligation of defense services for all civilians, the organization of the defense service, the combatant forces, and the civil defense are briefly described. The mission and organization of the civil protection force and the alarm service are given. Evacuation plans and the construction of fallout shelters are discussed. The local forces available for all out defense including the mobile forces and the industrial civil protection are described. (J.S.R.)

Facilities and Equipment

Refer also to abstracts 16632, 16636, 16769, 16794, 17439, 17441, 17563, 17565, 17579, 18672, and 18675.

16735 (BAW-1280-48) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Quarterly Progress Report, July–September 1967. (Babcock and Wilcox Co., Barberton, Ohio. Boiler Div.). Feb. 12, 1968. Contracts AT(11-1)-1280; 610-0067. 11p. Dep. CFSTI.

Fabrication of the Prototype Steam Generator was held up pending resolution of metallurgy problems associated with the overheated tube. Recommendations were made for resolution of the problems. Task II, the sodium to steam heat exchanger study, containing preliminary cost trends and preliminary specifications was submitted to the Commission for review and comment. (auth)

16736 (BMwF-FBK-67-86) AUFBAU UND ERPROBUNG EINER ANLAGE ZUR HOCHTEMPERATUR-DIFFERENTIAL-THERMOANALYSE. (Arrangement and Testing of an Apparatus for High-Temperature Differential Thermal Analysis). Roesch, D.; Lukas, H. L.; Goretzki, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart (West Germany). Institut fuer Sondermetalle). Oct. 1967. 38p. (In German). Dep.

An apparatus suitable for high-temperature differential thermoanalysis has been set up. The samples are induction-heated, and the power is continuously altered by slow variations of the rated value of the control unit. The temperature of the sample is pyrometrically measured and electronically differentiated with respect to time. The resulting dT/dt (T)-diagrams are plotted by an x-y-recorder. The apparatus, now being used for investigations at 1000 to 2300°C, can be applied up to 3600°C. During testing of this device, investigations in the systems Mo–C and Cr–Nb have been carried out. In the future, the apparatus will be used for constitutional studies of refractor compounds of U and Be as well as elements of the IV and Va group of the periodic system. (auth)

16737 (CEA-R-3312) ESSAIS DE DECONTAMINATION DE MATERIEL CONTAMINE PAR DU TRITIUM. (Decontamination Tests on Tritium-Contaminated Materials). Boutot, Pierre; Schipfer, Pierre (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Dec. 1967. 18p. (In French). Dep.

These tests are designed to try out various processes to be applied to the decontamination of a material contaminated with tritium. The samples are thin stainless-steel slabs contaminated in the laboratory with elements extracted from industrial installations. The measurement of the initial and residual activities is carried out using an open-window BERTHOLD counter. The best results are obtained by passing a current of pre-heated (300°C) air containing water vapor. This process makes it possible to reach a decontamination factor of 99.5 percent in 4 hours. In a vacuum, the operation has to be prolonged to 100 hours in order to obtain a decontamination factor of 99.2 percent. Wet-chemical or electrolytic treatments are efficient but their use is limited by the inherent corrosion risks. A study of the reappearance of the contamination has made it possible to observe that this phenomenon occurs whatever the process used. (auth)

16738 (JAERI-1153) JRR-2 IRRADIATED FUEL STORAGE FACILITY. Sawai, Sadamu; Ueno, Mitsuyasu (Japan Atomic Energy Research Inst., Tokyo). Sept. 1967. 18p. Dep.

The irradiated fuel storage facility and the experiences are described. The troubles and problems encountered, such as the pool lining, irradiated fuel storage rack, handling tools and the operation data on the water quality of the pool are also reported. (J.C.W.)

16739 (SC-DR-67-115) GB-60A LIGHT DETECTING AND RANGING SYSTEM (LIDAR). Landry, Murphy J. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. 39p. Dep. CFSTI.

A laser light detecting and ranging (LIDAR) system was developed primarily for use in tracking clouds formed by the ablation of radioactive materials ejected from a SNAP device during atmospheric reentry. The GB-60A, a first generation LIDAR system which has been used to observe thin atmospheric clouds, retro reflectors, balloons, and discontinuities in the atmosphere, is described. The range equations, system parameters, design details, and operation techniques associated with the system are described. (auth)

16740 (WB-KE-2004) STEAM GENERATORS FOR MODERN GAS-COOLED REACTORS. Gilli, P. V. (Waagner-Biro A. G., Vienna (Austria)). [1967]. 43p. Dep.

Gas-cooling of advanced converter or breeder reactor systems of high thermal efficiency is investigated, with emphasis on the effects of coolant choice and coolant pressure on size and therefore cost of core and particularly of steam generator. For the fixed geometry/variable power case, the dependence of power density, and for the fixed power/variable geometry case the dependence of face area, length, power density, specific gas mass flow rate, velocity, velocity head, pressure drop, and Reynolds number on steam data on the one hand and on thermal properties and pressure of the coolant on the other, is developed analytically and the main results are presented graphically. Although at the pressures and temperatures concerned carbon dioxide is superior to helium in the fixed geometry approximation, it is shown that for the variable geometry case—which applies if a steam generator is to be designed—and particularly for cross-flow, helium is superior to carbon dioxide in terms of power density that is it leads to much smaller size, and therefore to lower cost, of the steam generator tube bundles. Argon is inferior to helium and carbon dioxide in both cases. (auth)

16741 THE FIRST INDUSTRIAL GAMMA-IRRADIATION PLANT ON THE EUROPEAN CONTINENT. Kuenzli, A.; Baur, P. Isotop. Radiat. Technol., 5: 142-5(Winter 1967-68).

Description is given of a ^{60}Co medical-supply sterilization plant (600,000 Ci capacity) built in Melsungen, West Germany. This includes plant layout and mode of operation, shielding and radiation monitoring, radiation source, ventilation, and control and safety interlocks. (P.C.H.)

16742 TRAVELING EXHIBIT ON USES OF IRRADIATION TECHNIQUES. Isotop. Radiat. Technol., 5: 145-7(Winter 1967-68).

Description is given of a ^{137}Cs irradiation facility to be used for demonstrating industrial applications of irradiation techniques. (P.C.H.)

16743 RADIOISOTOPE-POWERED SUBMERSIBLE ENGINE. Isotop. Radiat. Technol., 5: 148-54(Winter 1967-68).

A conceptual design for a Radioisotope Submersible Engine (RISE) is presented. This unit, which is designed to produce 3 kW(e) for 10 thousand hr, is powered by 1.59 Mc of ^{60}Co. It operates on a dynamic closed Rankine cycle with Dowtherm A as the working liquid. With suitable modifications the design can produce 2 to 20 kW(e). (auth)

16744 RELATION OF DESIGN PARAMETERS, PLANT CAPACITY, AND PROCESSING COSTS IN ^{60}Co STERILIZATION PLANTS. Brown, M. G. (Atomic Energy of Canada Ltd., Ottawa). Isotop. Radiat. Technol., 5: 235-41(Spring 1968).

The main features of three sizes of ^{60}Co sterilization plants, designed to provide a complete range of capacities for radiosterilization of medical products, are described. The smallest plant has a capacity of up to 50 thousand ft^3 of medical products per year; the intermediate, up to 500 thousand ft^3; and the largest, over 1 million ft^3. The relations between capital costs, production rate, efficiency, and unit processing costs for each size of plant are discussed, and the method for selecting the best size of plant for a particular need is outlined. (auth)

16745 INTEGRATED WASTE-MANAGEMENT SYSTEM WITH A VACUUM DISTILLATION-VAPOR PYROLYSIS RADIOISOTOPE-FUELED WATER-RECLAMATION FUNCTION. Metzger, C. A. (Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio); Hearld, A. B.; Reynolds, B. J.; Shivers, R.; Murray, R. W. Isotop. Radiat. Technol., 5: 242-51(Spring 1968).

The first prototype of a total waste-management system for an aerospace life-support system with the water-recovery function thermally powered by a radioisotope is reported. Five hundred grams of ^{238}Pu [0.56 watt(t)/g] was used to supply a total of 280 watts(t) from four 70-watt(t) heat sources. The small electric-power requirement for the pumps and valves was met by small external supplies. The prototype was designed and tested to supply two men with water for a 30-day mission, and it recovered approximately 0.75 lb of water per hour from waste liquids. (auth)

16746 RADIOACTIVE WASTE CONTAINERS FOR DEEP SEA DISPOSAL. Sasaki, Tadayoshi (Tokyo Univ. of Fisheries). Genshiryoku Kogyo, 13: No. 9, 20-6(Sept. 1966). (In Japanese).

Containers for the deep-sea disposal of radioactive wastes are described. Studies and experiments were made on the shape, strength, anti-corrosion, and rate of falling and settlement on the sea bed. The cylindrical containers, made of mortar, can be designed by means of the experimental t/r value, where t is the wall thickness, and r is the average radius. In steel drums the weight loss, due to corrosion, decreases with the lapse of days, taking an approximately constant value after about 100 days. In the deep-sea disposal of the mortar containers, the effect of the sea depth, i.e., water pressure, upon the number of "container safe" days is fairly large. The development of a method for preventing water passage through the mortar is necessary. In dropping to the sea bottom, the use of a parachute, or the choice of a suitable sea bed position is in some cases necessary to ensure the integrity of the containers. (NSA of Japan)

16747 AUSTRALIAN HIGH ACTIVITY HANDLING CELLS. Nucl. Eng., 13: 125-6(Feb. 1968).

A description is given of a block of 4 in-line interconnected cells, each capable of handling 100,000 MeV Ci γ radiation. Examples are given of the wide variety of work for which these cells are expected to be used. (UK)

16748 USING NUCLEAR ENERGY FOR MAKING IRON. Wenzel, Werner (Technical Univ., Aachen). Euratom Bull., 6: 115-20(Dec. 1967).

Electrolysis and carboelectric techniques for iron production using cheap power were investigated. Neither aqueous nor fusion electrolysis may be used. Electroreduction must compete with blast furnace plants with regard to investment and operation. The use of electrical energy is feasible when the quantity of available fossil fuel is limited. When cheap nuclear energy is available it will be more frequently used. (F.S.)

16749 CABLE-TYPE QUICK RELEASE COUPLING. McLellan, J. J. (to Atomic Energy of Canada Ltd.). Canadian Patent 763,650. July 25, 1967.

A device designed for changing an exhausted source in a radiographic camera without exposure to the operator is described. Springs or special tools are not required and indication of proper connection is provided. The essential parts are an eye and an aperture, a re-entrant projection, a locking lug and a flexible cable. Connection with the radioactive source for insertion or withdrawal is made by rotation of the flexible cable. (F.S.A.)

16750 OCCUPANCY STANDARDS AND PROCESS HAZARDS. National Fire Codes. A Compilation of NFPA Codes, Standards, Recommended Practices, and Manuals. Volume 9, 1967-68. AIA File Number 40-B-7. Boston, National Fire Protection Association, 1967.

Seventeen fire protection standards are presented. Separate abstracts were prepared for two standards. The remaining fifteen standards are concerned with wood and forest products, explosions, static electricity, furs, ovens and furnaces, piers and wharves, garages, dehydrators and dryers, homes, indoor and outdoor storage, records, and community dumps. (R.C.K.)

For abstracts of individual papers see: 16751 and 18610.

16751 RECOMMENDED SAFE PRACTICE FOR LABORATORIES HANDLING RADIOACTIVE MATERIALS. Nat. Fire Codes, 9: 801.1-41(1967-68).

Recommended safe practices for laboratories handling radioactive materials are presented. The types of radioactive materials commonly used in laboratories are discussed. Laboratory types, construction details, equipment, and service facilities are described. Fundamental fire characteristics, safeguards, and fire protection systems are discussed. (R.C.K.)

Heat Transfer and Fluid Flow

Refer also to abstracts 16721, 17446, 17834, 17835, 18580, 18663, 18664, 18666, 18673, and 18677.

16752 (AAEC/TM-398) FLOW EXPERIMENTS ON PACKED BEDS USING THE UNIVERSITY OF ADELAIDE WATER TUNNEL. Saiva, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sept. 1967. 27p. Dep.

Experiments were carried out to determine pressure drop and flow distribution data for packed beds of spheres. Two randomly packed and two regularly packed beds were investigated. The preparation, assembly and testing of these sphere packings are described and the results analyzed and discussed. The friction factors for the two regular beds were found to be higher than for the two random beds. The agreement of the random bed data with that from similar studies is good. Flow profiles, except for the wall region, were essentially flat and independent of Reynolds number. (auth)

16753 (CONF-671211-1) DISTRIBUTION OF FLUID VELOCITIES FOR RANDOMLY PACKED BEDS IN SPHERES. Price, J. (Austrialian Atomic Energy Commission Research Establishment, Lucas Heights). [1967]. 9p. Dep.

From Conference on Thermodynamics and Fluid Mechanics, Brisbane, Australia.

Fluid velocity distributions in randomly packed beds are of interest in the design of heat and mass transfer systems, including pebble bed nuclear reactors. The literature is briefly reviewed. Discrepancies exist in the data for similar beds and attention is drawn to the limitations of theoretical solutions. The methods of measurement used by previous investigators are appraised. Measurements of the fluid velocity distributions (i.e., flow rate distribution referred to the corresponding open tube area) are presented for a number of randomly packed beds of spheres. A honeycomb was placed between the exit face of the bed and the plane of measurement. The results show that a region of high velocity existed within one-half sphere diameter from the walls of the containing vessel and that over the rest of the bed the departures from uniformity were small. The distribution was independent of Reynolds number ($1,470 < N_R < 4,350$) and bed length ($9 < L/d < 36$). Slight systematic effects were observed near the walls due to the packing method, sphere properties, and vessel to sphere diameter ratio ($12 < D/d < 48$). The results differ substantially from those of previous investigators whose measurements were made at exit from the bed. They are in accord with measurements made inside the bed. (auth)

16754 (LA-3854) TRANSPORT OF TURBULENCE ENERGY DECAY RATE. Harlow, Francis H.; Nakayama, Paul I. (Los Alamos Scientific Lab., N. Mex.). Jan. 1968. Contract W-7405-eng-36. 7p. Dep. CFSTI.

The second of two previously proposed turbulence transport equations is here derived so as to determine the variation of several of the universal functions. The derivation also extends the usefulness of the equations, strengthens their validity, and clarifies the interpretations of the turbulence fields variables. (auth)

16755 (NYO-3679-3) HEAT TRANSFER AND HYDRAULICS: THE EFFECTS OF SUBCOOLED VOIDS. Quarterly Report No. 3, October–December 1967. Staub, F. W.; Walmet, G.; Niemi, R. O. (General Electric Co., Schenectady, N. Y. Research and Development Center). Contract AT(30-1)-3679. 42p. (EURAEC-1977). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

The analytical effort to derive general equations which accurately predict the void fraction, pressure drop, and heat transfer coefficients in two-phase flow with subcooled boiling for various fluids over a wide range of operating conditions is described. Single phase tests at low heat flux were made to serve as a calibration for the measurements and a standard for subsequent comparison with two-phase data. Temperature and velocity profiles were correlated. Needed modifications in the insulation in back of the heated section and in the heater support of the test loop were completed. Excitation voltage correction for the heated wall thermocouples were calibrated and it was shown that the conduction error correction for the thermocouple traversing probes is necessary. The effect of undeveloped temperature profiles on the prediction of net void inception is given. (F.S.)

16756 (BNL-tr-184) EFFECT OF OXIDES ON HEAT TRANSFER DURING CROSS FLOW OF SODIUM THROUGH A STAGGERED TUBE BANK. Borishanskii, V. M.; Zhinkina, V. B.; Firsova, E. V. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from At. Energ. (USSR), 22: 317-18 (1967). 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

This paper was abstracted from the original language and appeared in NSA as 21: 39118. (F.S.)

16757 A STUDY ON THE HEAT CONDUCTION AT THE CONTACT OF METALS. II. THE INFLUENCE OF THE THICKNESS OF A CONTACTING SOLID, AND THE DIFFERING CONDITIONS IN THE CONTACTING SOLIDS. Sanokawa, Konomo (Japan Atomic Energy Research Inst., Tokyo). Nippon Kikai Gakkai Rombunshu, 33: 1108-1119(July 1967). (In Japanese).

In reactor fuel rods, where the contact heat resistance is a serious problem, cladding is usually 1 to 2 mm in thickness. A study was made to determine whether the model of a semi-infinite, cylindrical unit cell could be applied for the calculation of contact heat resistance and on problems arising from the differing contact materials. In this unit cell model, it is assumed that the heat flow is concentrated on the point of each contact. When the thickness of a contacting solid is over about 1 mm, use of the unit cell model gives fairly good results of the contact heat resistance. For the case where the two contacting materials, and the roughness of the two surfaces differ considerably, a formula of calculation is also proposed. (NSA of Japan)

16758 A STUDY ON THE HEAT CONDUCTION AT THE CONTACT OF METALS. I. THE CASE OF THE SAME CONDITIONS IN TWO CONTACTING SOLIDS. Sanokawa, Konomo (Japan Atomic Energy Research Inst., Tokyo). Nippon Kikai Gakkai Rombunshu, 33: 1097-1107(July 1967). (In Japanese).

The problem of a contact heat resistance is treated both theoretically and experimentally; and a theoretical interpretation of this phenomenon is given. It is pointed out that the conventional methods are not valid for the case of the oxidized contact surfaces. And, a convenient method is proposed for the calculation of the contact heat resistance, through the theoretical considerations. The cause of the contact heat resistance, viewed from the theory of heat conduction, can be ascribed to the contraction and expansion of heat flow in the contacting surfaces. To calculate the value of heat resistance, use is made of a unit cell model where the heat flow is concentrated on a point of contact; here, the complicated configuration of the surfaces are approximated. The method proposed has the following features: it satisfies the condition of equal heat fluxes at each point, and the solution approaches a rigorous one simply by increasing the approximations. (NSA of Japan)

16759 A STUDY ON THE HEAT CONDUCTION AT THE CONTACT OF METALS. III. THE CASE OF THE OXIDIZED CONTACTING SURFACES. Sanokawa, Konomo (Japan Atomic Energy Research Inst., Tokyo). Nippon Kikai Gakkai Rombunshu, 33: 1120-30(July 1967). (In Japanese).

The contact heat resistance when the contacting surfaces are oxidized (or corroded), in contrast to the nonoxidized case, is considerably influenced by two facts, i.e., the larger degree of surface roughness plus its irregularity, and the existence of a layer of a "foreign" substance having a different heat conductivity from that of the metals. These irregularities include the sporadic projections of rust, and the changes in roughness on the surface. In the estimation of the contact heat resistance in such cases the maximum height of projections, the average level of roughness, and the roughness contrasted to that before the oxidization must be considered. The results calculated agree with the experimental ones to this degree. The contact heat resistance for the oxidized surfaces is larger than that of the nonoxidized ones, and its change by the pressing force applied to the contact is lower, indicating the smaller heat conductivity of the foreign substance than that of the metals. (NSA of Japan)

16760 A STUDY ON THE HEAT CONDUCTION AT THE CONTACT OF METALS. IV. THE INFLUENCE OF THE SURFACE CONFIGURATION, UNDULATIONS, AND THE APPROXIMATION METHODS FOR CALCULATION OF THE CONTACT HEAT-RESISTANCES. Sanokawa, Konomo (Japan Atomic Energy Research Inst., Tokyo). Nippon Kikai Gakkai Rombunshu, 33: 1131-7(July 1967). (In Japanese).

The undulations on the contacting surfaces may be considered as a large degree of the surface roughness. The contact heat resistance can be estimated by combining the resistance due to the heat flow contraction and expansion of the undulations, and the resistance due to the equivalent ones of the roughness at the undulation contacts. When the pressing force is large, it is approximately an algebraic sum. Which of the two predominates depends on the particular circumstances, but in some cases the contact heat resistance is mostly caused by the former, which deserves considerable care. In the calculation of a variety of the contact heat-resistances, the methods previously described may be used. A convenient, approximation method is presented and the extent of its application is discussed. (NSA of Japan)

16761 FLOW RATE MEASUREMENTS OF CONDENSABLE GASES BY THE CARRIER-GAS METHOD. Fries, B. A. (Chevron Research Co., Richmond, Calif.). Int. J. Appl. Radiat. Isotop., 19: 39-42(Jan. 1968).

The flow of a condensable gas, such as steam, can be measured with noncondensable krypton-85 tracer by a modification of the total-count method. A noncondensable carrier gas is added to a sample stream just ahead of a condenser which removes the condensable gas. The carrier gas then carries the tracer through a counting chamber. From the known rate of flow of the carrier gas, the measured rate of collection of condensate, and the total counts registered by a Geiger-Müller counter sensitive to krypton-85 beta rays, the condensable gas flow rate may be calculated. The method was successfully tested on high pressure steam flows. (auth) (UK)

16762 PUFL: AN "ALMOST-LAGRANGIAN" GASDYNAMIC CALCULATION FOR PIPE FLOWS WITH MASS ENTRAINMENT. Crowley, Barbara K. (Univ. of California, Livermore). J. Comput. Phys., 2: 61-86(Aug. 1967). (UCRL-14536).

An "almost-Lagrangian" formulation in quasi-one-dimensional geometry for the conservation equations of gasdynamics is presented that considers zones with mass sources and sinks. The differential equations are first derived by an integral approach. Then, the corresponding finite-difference equations and the calculational scheme used in the PUFL code for advancing the difference equations is given. By considering uniform flows, analytical solutions for the PUFL equations with both mass sources and sinks are obtained. Stability of the "almost-Lagrangian" equations is empirically discussed and tested by comparison of PUFL calculations with the analytical solutions. It is found that when the fraction of mass in a zone changes by no more than ~1% in any one calculated cycle, excellent agreement with the analytical solution is obtained. By using an additional time-step control which limits the amount of mass change per cycle, the "almost-Lagrangian" formulation appears to be feasible. (auth)

16763 NUMERICAL METHOD FOR SOLVING INCOMPRESSIBLE VISCOUS FLOW PROBLEMS. Chorin, Alexandre Joel (New York Univ., N. Y.). Contract AT(30-1)-1480. J. Comput. Phys., 2: 12-26(Aug. 1967).

A numerical method for solving incompressible viscous flow problems is introduced. This method uses the velocities and the pressure as variables, and is equally applicable to problems in two and three space dimensions. The principle of the method lies in the introduction of an artificial compressibility δ into the equations of motion, in such a way that the final results do not depend on δ. An application to thermal convection problems is presented. (auth)

16764 CALCULATION OF STEAM VOLUME FRACTION IN SUBCOOLED BOILING. Rouhani, S. Zia (Aktiebolaget Atomenergi, Stockholm). J. Heat Transfer, 90: 158-64(Feb. 1968).

An analysis of subcooled boiling is presented. It is assumed that heat is removed by vapor generation, heating of the liquid that replaces the detached bubbles, and to some extent by single-phase heat transfer. Two regions of subcooled boiling are considered and a criterion is provided for obtaining the limiting value of subcooling between the two regions. Condensation of vapor in the subcooled liquid is analyzed and the relative velocity of vapor with respect to the liquid is neglected in these regions. The theoretical arguments result in some equations for the calculation of steam volume fraction and true liquid subcooling. (auth)

16765 ANALYSIS OF HEAT TRANSFER FOR FULLY DEVELOPED TURBULENT FLOW IN CONCENTRIC ANNULI. Wilson, N. W. (McMaster Univ., Hamilton, Ont.); Medwell, J. O. J. Heat Transfer, 90: 43-50(Feb. 1968).

The heat and momentum transfer analogy is employed to analyze the heat transfer phenomena for turbulent flow in concentric annuli. A modification of the velocity distribution due to Van Driest is assumed and equations in dimensionless form are developed to predict: (a) the position of maximum velocity in the annulus; (b) the friction factor-Reynolds number relationship, and (c) temperature distributions and heat transfer relations over a wide range of Reynolds number and Prandtl modulus. (auth)

16766 STUDY OF WALL-TURBULENCE PHENOMENA USING HOT-FILM SENSORS. Armistead, R. A. Jr.; Keyes, J. J. Jr. (Oak Ridge National Lab., Tenn.). J. Heat Transfer, 90: 13-21 (Feb. 1968).

Flush-mounted hot-film sensors were used to study local turbulence-induced fluctuations in the rate of heat transfer in pipe flow of water for a Reynolds number range of 11,000 to 170,000. Determinations were made of power spectral density, characteristic frequency (obtained from the rate at which the signal crossed its zero level), amplitude density, and intensity of the heat-transfer fluctuations. Studies of the relationship between the heat-transfer fluctuations in the vicinity of the wall indicated that a significant correlation existed which systematically decreased as the anemometer was moved from moderate distances upstream to moderate distances downstream of the wall sensor. Evidences of a periodic component were observed in the autocorrelation curves of velocity fluctuations in the vicinity of the wall for a Reynolds number of 52,000. The period determined was of the same order of magnitude as that predicted by Einstein and Li and Black sublayer flow models. (auth)

16767 AN EXPERIMENTAL STUDY OF FORCED-CONVECTION HEAT TRANSFER FROM A SPHERE TO LIQUID SODIUM. Witte, L. C. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. J. Heat Transfer, 90: 9-12(Feb. 1968).

Experimental heat-transfer rates from spheres moving through liquid sodium have been obtained. The experimental data were obtained by a transient technique in which a heated metal sphere was passed through a pool of liquid sodium. Heat-transfer rates up to 3.58×10^6 Btu/(hr)(ft^2) were calculated from the experimental measurements. Reynolds numbers, based on the sphere velocity and diameter, ranged from 35,000 to 153,000. The experimental data were correlated by an expression similar to theoretical expressions obtained from potential-flow theory. (auth)

Isotope Technology

Refer also to abstracts 16470, 16636, 16637, 16717, 16739, 16743, 16745, and 16761.

16768 (BNWL-680) DIVISION OF ISOTOPE DEVELOPMENT PROGRAMS QUARTERLY REPORT, OCTOBER-DECEMBER 1967. Moore, R. L. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 32p. Dep. CFSTI.

Separate abstracts were prepared for each of the eight sections presented. (B.G.D.)

For abstracts of individual sections see: 16478, 16642, 16769, 16770, 16925, 17101, 17156, and 17166.

16769 (BNWL-680, pp 2-4) A-CELL EQUIPMENT AND OPERATIONAL CHANGES. Wheelwright, E. J.; Roberts, F. P.; Berreth, E. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The A-Cell of the PNL High Level Radiochemistry Facility required decontamination when the largest column was found to be defective. Recently a 4 in.-ID glass column developed a crack in the water jacket. At this time the larger glass columns were replaced with stainless steel columns of a more optimum size. Success of the changes is confirmed by improvement in increased promethium material balance and a decrease in waste losses. (J.C.W.)

16770 (BNWL-680, pp A.1) CHARACTERISTICS OF RADIOISOTOPIC HEAT SOURCES. Rohrmann, C. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The characteristics such as half-lives, meeting points, density, availability, biological hazard, prices, and shielding required, for 11 radioisotopic heat sources are summarized. These include ^{60}Co, ^{90}Sr, ^{106}Ru, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{170}Tm, ^{210}Po, ^{238}Pu, ^{242}Cm, and ^{244}Cm. (J.C.W.)

16771 (CEA-R-3365) PREPARATION DES ETALONS DE GAZ RADIOACTIFS. (Preparation of Radioactive Gaseous Standard). Blondel, Maurice; Phan, Xuan Dao (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 35p. (In French). Dep.

To prepare a radioactive gaseous standard it is necessary on the one hand to put into a sealed vial a well-defined quantity of the gas concerned, and on the other hand to measure its specific activity. The determination of the quantity of gas which constitutes the standard implies accurate measurements of volume, temperature and pressure. To measure the specific activity, the method of compensated internal gas counters is used. The final accuracy on the specific activity of this standard is better than 0.8%. The validity of the method used for the measurements was checked by measuring the specific activity of the tritiated hydrogen extracted from a tritiated-water standard. (auth)

16772 (MLM-1451) DETERMINATION OF GASEOUS DIFFUSION COEFFICIENTS FROM APPROXIMATE VISCOSITY FORMULAS. Weissman, S. (Mound Lab., Miamisburg, Ohio). Mar. 4, 1968. Contract AT(33-1)-Gen-53. 14p. Dep. CFSTI.

The use of approximate formulas for the viscosity of gaseous mixtures to determine diffusion coefficients has two advantages over the use of the rigorous expression. First, the resulting expression for the diffusion coefficient is simpler, and second, the diffusion coefficient can be written solely in terms of experimental quantities and one empirical factor. When the viscosity-derived diffusion coefficients were compared with experimental diffusion coefficients, the Buddenberg—Wilke equation failed if the masses of the components were very different, but the equations proposed by Brokaw and by Francis gave satisfactory results. (auth)

16773 (STI/DOC-10/73) TRITIUM AND OTHER ENVIRONMENTAL ISOTOPES IN THE HYDROLOGICAL CYCLE. Technical Reports Series No. 73. Report of a Panel. (International Atomic Energy Agency, Vienna (Austria)). 1967. 83p. IAEA: $2.00; Austrian Schillings 52,-; 14/stg; F Fr 9,80; DM 8,-.

Tritium and stable isotopes in precipitation, oceanographic applications of cosmic ray and fallout isotopes, meterological and hydrological applications of tritium and other isotopes, and techniques for the collection and analysis of isotopic samples are discussed. (J.C.W.)

16774 (MLM-1485(tr)) THERMAL DIFFUSION OF ^{16}O/^{18}O IN A CLUSIUS-DICKEL COLUMN: COMPARISON OF RESULTS WITH THEORETICAL PREDICTIONS. Casas, J.; Saviron, J. M.; Quintanilla, M. Translated for Mound Lab., Miamisburg, Ohio, from An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 60: 167-74(1964). 17p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

This paper was previously abstracted from the original language and appeared as NSA 19: 28718.

16775 (MLM-1487(tr)) THERMODIFFUSION IN BINARY MIXTURES OF ISOTOPES OF NEON AND METHANE: DIFFERENCE IN BEHAVIOR OF THE MOLECULES ^{12}CH$_3$D AND CH$_4$ RELATIVE TO ^{20}Ne AND ^{22}Ne. Clusius, K.; Quintanilla, M. Translated for Mound Lab., Miamisburg, Ohio, from An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 60: 159-66(1964). 19p. Dep. CFSTI.

This paper was previously abstracted from the original language and appeared as NSA 19: 28292.

16776 CALCULATION OF THE COEFFICIENT OF SEPARATION OF ISOTOPES BY MULTISTAGE CONDENSATION OF ISOTOPIC MIXTURES. Mikhailichenko, A. I.; Shcheglov, O. F. Zh. Fiz. Khim., 42: 164-7(Jan. 1968). (In Russian).

An analytical method for calculation of the separation coefficients of isotopes by multistage condensation of isotopic mixtures was proposed. The formulas were used in all ranges of isotopic concentration and made it possible to take into consideration the loss of the partially enriched products. (tr-auth)

16777 AVAILABILITY OF STANDARDS FOR COMMON RADIONUCLIDES. Reynolds, S. A. (Oak Ridge National Lab., Tenn.). Isotop. Radiat. Technol., 5: 118-21(Winter 1967-68).

Radionuclides (93) for which standard preparations are available or needed are listed in a table, together with some sources of supply. Some discussion of the use and importance of radionuclidic standards is included. (auth)

16778 RADIOISOTOPIC METHOD FOR MEASURING THE TEMPERATURE OF A MOLTEN METAL. Isotop. Radiat. Technol., 5: 121-3(Winter 1967-68).

A method for determining the temperature of a molten metal from the intensity of the gamma radiation transmitted by it is described. ^{60}Co is used as the gamma source. (auth)

16779 TEN YEARS OF IAEA ISOTOPE WORK. Isotop. Radiat. Technol., 5: 157-8(Winter 1967-68).

A brief review is given on the main activities of IAEA in isotope technology during the last 10 years. Research in agriculture, hydrology, medicine, and industry are described. The functions of the IAEA are also discussed. (P.C.H.)

16780 ^{60}Co FOR POWER SOURCES. Ross, C. P. (E. I. du Pont de Nemours and Co., Inc., Aiken, S. C.). Contract AT(07-2)-1. Isotop. Radiat. Technol., 5: 185-94(Spring 1968). (DP-MS-67-90).

The status of the program at Savannah River Laboratory for the development of ^{60}Co as a radioisotopic power source is reviewed. The use of ^{60}Co as a power source, including coverage of applications, properties, shielding and containment, production and cost, and capsule material selection, fabrication, and testing are discussed. (auth)

16781 UTILIZATION OF RADIOISOTOPES FOR MEASUREMENT OF LEAKS IN CHEMICAL PLANTS. Hirayama, Toru; Nishimura, Kunio Genshiryoku Kogyo, 13: No. 8, 39-43(Aug. 1967). (In Japanese).

Leaks in chemical plants are a serious problem. In recent years the use of radioisotopes for its measurement has been developed. A description of the utilization of radioisotopes for this purpose is given in the following sections: features of leakage in the chemical plant; and planning of the leakage measurements, e.g., selection of suitable radioisotopes, the amount of radioisotope used and the time of sampling, selection of the measuring method and instrument, and the permissible radioisotope concentration. The following leakage measurements are described: the measurement of gas and water leakage in an ammonia plant using ^{85}Kr and ^{3}H respectively. Measurements of oil leakage in mechanical seals using ^{32}P as the tracer and water leakage in the Banbury mixer using ^{24}NaCl are also described. (NSA of Japan)

16782 RADIOISOTOPES IN FOOD PROCESSING. PART 2. ANALYTICAL AND TRACER TECHNIQUES. Longstaff, R. M. (United Kingdom Atomic Energy Authority, Wantage, Eng.). Atom, No. 136, 39-45(Feb. 1968).

The use of radioactive substances in analysis, and as tracers, is discussed under the following headings: analytical applications; plant maintenance; safety and legal requirements; tracers (safety in tracer studies; use of radioactive tracers in studies of plant kinetics, in filtration, ventilation and wear studies, and in leak detection; laboratory applications of tracers); procedure; and economics. (UK)

16783 A NEW TYPE OF CLUSIUS-DICKELS SEPARATION TUBE. Meinrenken, Juergen (Univ., Goettingen, Ger.). Ber. Bunsenges. Phys. Chem., 71: 1092-5(Dec. 1967). (In German).

Thermal diffusion column heated by several annularly arranged wires is described. It has the advantages of both the coaxial tube type and the hot wire type. Measurements of the approach to equilibrium in a hexanary isotope mixture reveal that the "theorem of the independent separation" is also applicable to the time-dependent separation factors Q. (auth)

16784 DETERMINATION OF RESIDENCE TIMES AND RESIDENCE TIME DISTRIBUTIONS BY THE INTEGRATED PULSE METHOD. Hovenkamp, S. G. (Central Research Inst., Arnhem, Netherlands). Int. J. Appl. Radiat. Isotop., 19: 63-7 (Jan. 1968). (In French).

Residence times and residence time distributions of complicated industrial systems can be determined with the aid of radioactive tracers. Most of the methods in use require accurate determination of the amount of activity which is injected into the system and good calibration of the detecting equipment. When the exit stream is analyzed continuously, the accuracy of the ratemeter often determines the quality of the results. A method is described which allows the determination of residence times and residence time distributions without knowledge of: the amount of activity injected; the efficiency of the detecting equipment; the volume of the system; and the flow rate in the system. The analyzing equipment consists of a suitable detector (G-M or scintillation type), connected to a simple scaler with overflow pulse output on each decade, and a recorder. The accuracy of the method is discussed. It is shown that special precautions must be taken when systems with various liquids are measured. (auth)

16785 DETERMINATION OF THE THERMAL DIFFUSION CONSTANT OF A MIXTURE OF ZIRCONIUM AND HAFNIUM TETRACHLORIDES. Dokl. Akad. Nauk SSSR, 176: 374-7 (Sept. 11, 1967). (In Russian).

The separation methods for gaseous mixtures, used primarily for separating isotopes, may be employed also to separate pairs of similar elements, such as zirconium and hafnium, niobium and tantalum, etc, which have different masses and form gaseous compounds. For this reason, the thermal diffusion separation process for zirconium and hafnium tetrachlorides at 300°C was investigated. The study included the determination of the separation factor and the thermal diffusion constant by labeling the mixture of the purified chloride with the radioactive ^{181}Hf isotope. The experiments were carried out in a low inertia furnace under conditions which prevented convection; changes of the gamma radiation intensity of the ^{181}Hf were used to determine the concentration changes in the system. The results indicated that the larger separation is obtained in a mixture of about 50 volume % $HfCl_4$. The thermal diffusion constant α was found to be practically temperature-independent. The mean value of α in the $HfCl_4$ concentration range from 10 to 74 volume % amounted to 0.047 ± 0.006. At lower $HfCl_4$ concentrations, the value of α became larger but this could not be explained satisfactorily. The thermal diffusion method is considered suitable to separate the chlorides of hafnium and zirconium. (TTT)

16786 A NEW ^{99m}TECHNETIUM GENERATOR USING MANGANESE DIOXIDE. Meloni, S.; Brandone, A. (Univ., Paris). Int. J. Appl. Radiat. Isotop., 19: 164-6(Feb. 1968).

The increasing interest of the availability of ^{99m}Tc arises from the large number of medical and biological scanning studies carried out using ^{99m}Tc. The differences between the proposed generators concern the Tc-Mo separation techniques used, as well as the source of 66 hr ^{99}Mo. Usually the ^{99}Mo parent is adsorbed on a material with strong and selective sorption properties, i.e., alumina, iron oxide, and hydrous zirconium oxide, from which the ^{99m}Tc daughter is eluted with different eluants. The eluted ^{99m}Tc solution is then either ready to be used for clinical investigation, or in need of more chemical treatment to remove those eluants which may be undesirable in direct medical applications. As far as the ^{99}Mo source is concerned, ^{99}Mo may be a separated fission product or may be obtained by neutron irradiation of Mo metal or MoO_3. By using the ^{99}Mo fission product a higher ^{99m}Tc yield is obtained, but the neutron irradiation of Mo seems to be more easily available. A new technetium-99m generator is proposed, using an MnO_2 adsorbing material whose adsorption properties have only recently been investigated. This generator presents some features that make it easy to prepare, and to operate. (auth)

Materials Testing

Refer also to abstracts 16779, 16792, 16922, 17073, 18665, 18668, and 18674.

16787 (BMI-1828) INVESTIGATION OF THE INITIATION AND EXTENT OF DUCTILE PIPE RUPTURE. Quarterly Progress Report, October-December 1967. Eiber, R. J.; Maxey, W. A.; Duffy, A. R.; Atterbury, T. J. (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1968. Contract W-7405-eng-92. 18p. Dep. CFSTI.

Nine full-scale experiments were conducted on 24-in.-OD by 1.50-in. nominal wall thickness A106B pipe. Six of these experiments employed through-wall notches—five under subcooled conditions, one under a wet vapor condition. The range of temperatures was 554 to 675 F. The other three experiments involved surface flaws—one under a subcooled condition, the other two under wet vapor conditions. The through-wall flaw formulation requires additional experimental verification to permit accurate prediction of the failure stresses of through-wall flaws at relatively high stress levels in the vicinity of the yield stress. The through-wall flaw formulation presently provides a reasonably accurate estimate of the failure stress in this region. The surface flaw experiments indicate that the predicted failure stresses are within ±5 percent of the experimental values. Additional work is needed to verify these results. Three types of fracture extension have been observed—complete rupture, short crack extension, and a leak. For material of a given toughness the first two are believed at this time to be dependent upon the geometry of the defect and the state of the pressuring medium. The third type is believed to be dependent only on the geometry of the defect for material of a given toughness. (auth)

16788 (SC-RR-67-832) AN IZOD-ROGOWSKI IMPACT TEST. Sowell, R. R.; Milton, O. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1968. Contract AT(29-1)-789. 22p. Dep. CFSTI.

The Izod impact test was modified for the use of a plastic test specimen fabricated with a Rogowski contour in place of the usual notch. It was found that the energy required to break the test specimen was dependent upon the temperature of the specimen and that a significant change in the energy required for break occurred at the glass transition temperature of the material of the specimen. It was also found that the energy values obtained for a sample lot of test specimens fit an extreme value statistics and thus allow interpretation of data scatter. (auth)

16789 APPLICATION OF RADIOISOTOPES FOR SURFACE-AREA AND ROUGHNESS MEASUREMENTS. Kivel, Joseph (Atlantic Research Corp., Alexandria, Va.). Isotop. Radiat. Technol., 5: 112-17(Winter 1967-68).

Radioisotope techniques for determining surface areas and roughness are reviewed. The techniques involve the formation of a monolayer of a labeled reagent on the surface to be measured and subsequent counting. The use of various labeled organic reagents, including surfactants, is described, and surface-area values obtained by the radioisotope method are compared with those obtained by Brunauer, Emmett, and Teller (B.E.T.) method. (auth)

16790 INITIAL DEVELOPMENT OF NEUTRON RADIOGRAPHY IN FRANCE. Barton, J. P. (Argonne National Lab., Ill.); Boutaine, J. L. Isotop. Radiat. Technol., 5: 214-18 (Spring 1968).

Development of the technique of using neutrons for radiography started about 2 years ago in France, and both routine application and long-term research are now under way in several laboratories. A highly collimated thermal-neutron beam from a nuclear reactor is being used as a method of examination, and the technique may find valuable application in a variety of fields both inside and outside the nuclear industry. (P.C.H.)

Protective Structures

16791 (ORNL-TM-2041) DEFENSE SYSTEM DESIGN MODEL. Uher, R. A. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 27p. Dep. CFSTI.

A model is presented which optimizes strategic defense. Surviving population is considered the measure of the effectiveness of the defense system which can include active and passive elements. If the attack size and defense budget are specified, the model produces optimum active and passive defense mixes and allocates defense spending to regions of the United States according to population density. (auth)

Radioactive Material Handling

Refer also to abstracts 16746 and 18577.

16792 (ORNL-TM-2102) ACCELERATED DEFORMATION OF ROCK SALT AT ELEVATED TEMPERATURE AND PRESSURE AND ITS IMPLICATIONS FOR HIGH-LEVEL RADIOACTIVE WASTE DISPOSAL. Lomenick, T. F. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 119p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

With the storage of high-level radioactive waste in salt structures, unique mine stability problems will occur as a result of the elevated temperatures. To predict flow in rock salt, scale models of salt pillars and their surrounding rooms were fabricated from cores taken in the Carey salt mine, Lyons, Kansas. Tests were conducted at temperatures of 22.5°, 60°, 100°, and 200°C for axial loads of 2,000, 4,000, 6,000, 8,000, and 10,000 psi at each temperature. These tests showed that marked increases occur in the rates of deformation of salt pillars at high loads and especially at elevated temperatures. For all combinations of axial loads and temperatures, it was observed that there is initially a high rate of deformation that diminishes with time. Creep rates were found to continue to decrease even after more than 3 years of testing. An empirical relationship between pillar deformation, stress, temperature, and time was developed from the tests and is expressed as $\dot{\epsilon} = 0.39 \times 10^{-37}\ T^{9.5}\ \sigma^{3.0}\ t^{-0.70}$, $\epsilon = 1.30 \times 10^{-37}\ T^{9.5}\ \sigma^{3.0}\ t^{0.30}$, where $\dot{\epsilon}$ = strain rate (in./in./hr.), ϵ = cumulative deformation (in./in.), T = absolute temperature (°K), σ = average pillar stress (psi), and t = time (hr.). For comparative purposes, model pillar tests were conducted on samples of bedded salt, as well as on dome salt from six different mines in the United States and from the anticlinal structure of the Asse II salt mine in Northeast Germany. In general, the deformational behavior for the various types of salt were similar at room temperature as well as at elevated temperature even though some variations in the rates of deformation were observed. From model tests it was also observed that greatly accelerated rates of deformation will occur in excavated cavities where thin shale beds occur in the pillars at the roof and floor interfaces. Since the shales serve as friction reducers, effective confining stresses in the roof and floor are not transmitted into the pillars; thus the pillars under these conditions are weaker than where shale partings are not present at the tops and bottoms of the pillars. (auth)

16793 (STI/PUB-156) DISPOSAL OF RADIOACTIVE WASTES INTO THE GROUND. Proceedings Series. Proceedings of a Symposium held in Vienna, 29 May–2 June 1967. (International Atomic Energy Agency, Vienna (Austria)). 1967. 676p. (CONF-670512). IAEA: $14.00; Austrian Schillings 362-; £4.18.10; F Fr 68,60; DM 56,-.

Forty-three papers were presented at the conference. Separate abstracts were prepared for thirty. The remaining papers previously appeared in NSA. For abstract numbers of these see CONF-670512 in the Report Number Index. (R.C.K.)

For abstracts of individual papers see: 16795–16824.

16794 INSTRUMENTATION AND OPERATION OF THE RADIOACTIVE WASTE TREATMENT FACILITIES AT THE JAPC TOKAI POWER STATION. Kadoya, Shozo; Muramatsu, Takio (Ebara Mfg. Co., Ltd., Tokyo). Yosui To Haisui, 9: 20-5(July 1967). (In Japanese).

The disposal of radioactive liquid waste is the most difficult of the various industrial liquid wastes, because of its radioactivity. A description is given of the radioactive liquid waste treatment plant at the JAPC Tokai power station, where such wastes come mainly from the spent fuel storage ponds and the equipment decontamination facilities. The plant consists of a CO_2 cooled, graphite moderated, Calder Hall type reactor. Water from the spent fuel storage ponds is treated by neutralization with CO_2 gas and condensation-precipitation and sand bed filtration and ion-exchange. Treatment of miscellaneous liquid wastes by condensation-precipitation, sand bed filtration and ion exchange, and evaporation are described. (NSA of Japan)

16795 TRENCH DISPOSAL OF SOLID RADIOACTIVE WASTE FROM THE WINDSCALE AND CALDER WORKS OF THE UKAEA. Howells, H. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 3-13 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

Windscale and Calder Works of the UKAEA is situated in Cumberland on the northwest coast of England. Large volumes of low-activity and suspect active solid wastes arise both from process and laboratory operations. The total quantity is about 1000 tons/yr with an uncompressed volume of about 6000 m^3. It is impracticable to use monitoring as a method of segregation into active and inactive fractions. Consequently, all the material must be treated as radioactive waste and disposed of correspondingly. A study of the relative cost of disposal methods has emphasized the expense of pretreatment such as incineration or baling and shown that local burial without treatment is by far the cheapest method of disposal. This method is possible only if a suitable burial site is available close to the origin of the wastes. If this is not the case, pretreatment becomes necessary to ease the transport problems. Such a site exists near Windscale and the wastes are collected in transportable containers designed for dumping operations. These containers are picked up by a special vehicle, taken to the burial site and emptied into a trench. The material is covered with earth as dumping proceeds. Monitoring of water from the site shows negligible activity. (auth)

16796 DISPOSAL OF LOW- AND INTERMEDIATE-LEVEL SOLID RADIOACTIVE WASTES. Iranzo, E.; Mingarro, E. (Junta de Energia Nuclear, Madrid). pp 61-77 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967. (In Spanish).

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

In view of the future importance of radioactive waste disposal and burial in the ground, studies have been undertaken to find suitable sites for this purpose in Spain. The geographical, geological, hydrological, petrographical and seismological considerations which led to the choice of some old mines in the south of Spain as storage sites for low- and intermediate-level wastes are described. The availability of these sites will ensure that enough space is available to meet the requirements of the Spanish nuclear energy program for a very considerable time. (auth)

16797 EXPERIENCES WITH GROUND DISPOSAL AT CHALK RIVER. Merritt, W. F.; Mawson, C. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 79-92 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

The soil at Chalk River is quite shallow and consists mainly of sand. It has a low exchange capacity, but is very permeable. Large disposals of radioactive wastes have been made into this soil, in solid and liquid form, both experimentally and as part of the normal waste management program. The experiments included the pumping of kilocurie amounts of mixed fission products, dissolved in nitric acid, into soil pits. An emergency disposal of mixed fission products suspended and dissolved in water, resulting from a reactor accident, was also made directly into the sand. The geology and soil structure are known in considerable detail, and the hydrology of the region around the waste management areas has been studied intensively. A description is given of the rate and direction of movement of radionuclides through the soil, and particularly in the ground water. It will be shown that, even under the difficult conditions at Chalk River, direct disposal into the ground has been both convenient and safe. The amount of ground used has been small, and movement of radionuclides through the soil has been extremely limited. Decay of radionuclides during their slow movement makes ground disposal a safe operation if ground conditions are adequately known. (auth)

16798 GROUND WASTE DISPOSAL PRACTICES AT THE SAVANNAH RIVER PLANT. Marter, W. L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. pp 95-106 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

Solid radioactive waste has been buried at the Savannah River Plant since 1953. The waste, consisting of equipment and material contaminated with fission products, activation products, and transuranic isotopes, has been buried in unlined earthen trenches above the water table. A total of 1,500,000 Ci of fission and activation products and 9000 Ci of transuranic elements have been buried through 1966. Materials containing long-lived transuranic isotopes such as ^{239}Pu are encapsulated in concrete to permit retrieval for more permanent storage. The average cost of all land burial is \$35.00/m^3, but burial of transuranic isotopes is higher because of concrete encapsulation. Disposal of high-activity gamma waste is also more costly because of increased handling problems. In thirteen years, no radioactive materials have been detected in ground water underlying the burial trenches, and no significant amounts are expected to outcrop at the surface on the flood plain of a Savannah River tributary. Low-level liquid wastes, mainly from chemical separation areas, are discharged to connected earthen seepage basins. Water level in these basins remains essentially constant because seepage and evaporation are about equal to the volume of rainfall and the influent liquid waste. Liquid wastes are analyzed both before and after disposal in seepage basins. Procedural release guides limit the amount of each isotope discharged because certain long-lived isotopes, such as ^{90}Sr and ^{137}Cs, could eventually outcrop at a Savannah River tributary. A total of 1500 Ci of fission products (exclusive of tritium) and 13 Ci of transuranic elements have been committed to seepage basins. Only tritium oxide (a ternary fission product) has been detected in a surface stream. This occurred where the seepage basins were close to a stream. The soil surrounding the basins has an ion-exchange capacity that delays the movement of radioactive materials other than tritium oxide. The long travel time to reach a stream, and limits on amounts discharged to the basins, limit the amount of radioactive materials in the off-site environment to levels that will result in exposures far below those set by the Federal Radiation Council. Seepage basins cost about \$0.25/m^3 to construct, and experience indicates that the useful life of a basin is greater than 10 years. (auth)

16799 GROUND DISPOSAL METHODS FOR RADIOACTIVE SOLID WASTES AT THE ISPRA ESTABLISHMENT OF EURATOM. Fontaine, G. (European Atomic Energy Community, Ispra, Italy). pp 109-21 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967. (In French).

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

Radioactive solid waste produced in the reactors and laboratories of the Ispra establishment of Euratom can be divided into highly contaminated but nonactivated waste (waste from laboratories, hot cell decontamination, etc.), and highly activated but lightly contaminated waste (waste from in-pile loops and experiments). Ground disposal methods are used only for the latter category of solid waste and only if there is no material in the waste which can react with the cement. Various methods have been considered and utilized, underground wells being utilized in each case. A study of construction cost revealed an economical solution with respect to high-level activity and security, which also covers direct irradiation and the eventual transfer of contamination. (auth)

16800 MODEL EXPERIMENTS ON FLUID FLOW IN THE TRANSITION ZONE FROM UNSATURATED TO SATURATED SOIL. Schwille, F.; Lippok, W.; Weisflog, D. (Bundesanstalt fuer Gewaesserkunde, Koblenz, Ger.). pp 151-60 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

Since central water supply systems were established in Germany, ground water has been preferred as a water source and will undoubtedly continue to be so. More than four-fifths of the necessary drinking water is extracted from the sub-soil either as genuine ground water or as bank-filtered river water. The most important aquifers in the Federal Republic of Germany are fluviatile and fluvioglacial Pleistocene sand and gravel deposits, situated in the valleys of the large rivers. The ground-water level is generally from 3 to 15 m below ground surface. Depending on the permeability of the sub-strata, about 100 to 300 mm of precipitation water probably infiltrates. Therefore, the possibility of ground-water contamination by dissolved products is always present. These alluvial plains are suitable locations for radionuclide-producing plants. However, because of the intensive exploitation of the aquifers, it is hard to find any locality where such plants would not have a marked effect on the water supply system. If ground water is to be protected effectively and at reasonable cost against radionuclide contamination, a detailed knowledge is first necessary of the migration mechanisms of radionuclide-containing solutions both into the unsaturated zone, i.e., the aerated zone, and the saturated zone, since the migration of radionuclides depends on the static and dynamic behavior of fluids in porous media. Infiltration in the unsaturated zone and spreading in the saturated zone were analyzed with sand models scaled to resemble the natural conditions as closely as possible. Large special glass lysimeters, experimental troughs with glass walls and small diameter copper and glass segment-tubes were used as models. The liquid fronts were traced mainly with ultra-violet light. The result shows that it is not yet possible to treat the flow of liquid analytically in every case, even in homogeneous media. (auth)

16801 STUDIES ON ION DIFFUSION IN VERMICULITE. Levi, H. W.; Miekeley, N. (Hahn-Meitner Institut fuer Kernforschung, Berlin). pp 161-8 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

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Clay minerals are an essential part of many soils, and diffusion of radionuclide ions in the crystal lattices of those minerals consequently plays a role in radioactivity migration through soils. Ion mobilities in vermiculite as affected by the phenomenon of fixation are studied mainly by isotopic exchange. Among the radioactive ions showing fixation in vermiculite, cesium is the most important. It is shown that in a Cs saturated vermiculite only the fraction of Cs ions adsorbed at crystal imperfections is exchangeable. For the bulk of Cs no diffusion could be observed even at 100°C over a period of three months. In a vermiculite loaded with traces of Cs, however, these ions do not lose their mobility to this high degree. The behavior of vermiculite loaded with two ions, one of which was Cs, has been examined. In the case of Cs/alkaline earth, the latter was found to remain mobile but to become much slower. This shows that the presence of a nonhydrated and, consequently, fixed ion does not inhibit the migration of other ions in the vermiculite lattice. The conclusion is that it is not lattice-contraction associated with cesium uptake, but rather the state of the particular ion in the lattice that is responsible for the fixation phenomenon. Cesium fixed with respect to isotopic exchange was shown to become mobile by exchange with many other ions. These experiments give evidence of two different defixation mechanisms. Defixation may be caused by strongly hydrated ions as well as by relatively small nonhydrated ions. It is an interesting feature that fixed cesium ions may be exchanged against potassium, but potassium ions remain fixed against cesium. The results presented are discussed with respect to radionuclide migration in soils. (auth)

16802 MECHANISM OF RADIOACTIVE CONTAMINATION IN CONSOLIDATED IMPERMEABLE ROCKS OR ROCKS OF VERY LOW PERMEABILITY. Rancon, D. (Centre d'Etudes Nucleaires, Cadarache, France). pp 179-97 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967. (In French).

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The geochemical studies of radioactive contamination carried out so far have been mainly concerned with granular rocks (clay and soil) in which, owing to the infiltration of water, the radioisotopes are retained by micrograins or microcrystals of clay. But a circulation of radioactive effluents can also affect consolidated rocks which are impermeable or of very low permeability. The retention phenomena are then different, since they occur mainly on the surface. In order to determine the capacity of a body to retain a given radioisotope, use is made of the distribution coefficient or Kd. This value, which is characteristic of a granular rock for a given radioisotope, is not characteristic of a consolidated rock. A law was devised to express the variation of this Kd measured as a function of the thickness of penetration (e) of the liquid and of the dimension of the rock, which was experimentally verified by measuring the Kd as a function of the diameter x of the grains in the rock. Similarly it has been found that this measured Kd increases linearly with the specific surface of the rock. Thus, the Kd does not represent a physicochemical characteristic when applied to rocks of very low permeability, since it is dependent upon grain size and the specific surface. Accordingly, an alternative concept has been defined for uptake by rocks of this nature, i.e., the surface distribution coefficient, or Kd (S). Experience has shown that this value of Kd (S) was constant and characteristic of a rock and a radioisotope for a specific contact time. The methods used to ascertain the retention stability of the radioisotope on the rock and the kinetic study of its diffusion are described. (auth)

16803 PREDICTION OF RADIONUCLIDE MIGRATION IN GROUND WATER AT THE JAPAN ATOMIC ENERGY RESEARCH INSTITUTE. Inoue, Y. (Kyoto Univ.). pp 199-213 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

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The velocity of a radionuclide in ground water is related to the velocity of ground water, and the dispersion of radionuclides may be predicted from the dispersion of ground water. The application of the theory for the prediction of radionuclide movement at the Japan Atomic Energy Research Institute (JAERI) at Tokai-mura is described. JAERI is situated at Tokai-mura, where the formation consists of stratified and the loam layers, sloping about 10 degrees toward the Pacific Ocean. This sand layer holds the ground water. To determine the direction and velocity of ground-water flow, two methods were applied. One was to estimate ground-water flow by Darcy's law with the aid of permeability and equi-water level through measurements of ground-water levels at 53 observation wells throughout the area. The other method was a direct measurement of ground-water flow by the point dilution method, the results of which were used for the correction of data above. The distribution coefficient k_d may be obtained measuring the mass-action constant of the sand or by direct comparison of water and radionuclide travel by passing a radionuclide in ground water through a soil column. The value of k_d for strontium-90, for example, was 3.6. As the ground-water flow at Tokai-mura has a maximum speed of 16.7 m/day at the JRR-2 reactor site. ^{90}Sr travel is estimated to be 1.13 m/day at that location. The study is only applicable to the continuous pollution of ground water by radioactive material, and, in the case of an abrupt dose of radionuclides in ground water, the concentration is expected to be much less due to dispersion. To investigate this, water tracer was injected at one monitoring well and samples collected periodically at observation wells. Because of the slow movement of ground water (average 30 cm/day), this observation will need two to three more years before it is completed. (auth)

16804 INSTALLATION OF CHEMICAL BARRIERS IN AQUIFERS AND THEIR SIGNIFICANCE IN ACCIDENTAL CONTAMINATION. Baetsle, L. H. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.); Souffriau, J. pp 229-40 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

Principles of chemical barrier formation are reviewed, and the principal results of laboratory research on the system "Silica-HF-Antimonic acid" are discussed in some detail. Field experiments have delineated the zone created by injecting reagents traced with ^{82}Br into an aquifer. The economics of barrier formation are discussed in the conclusions. Finally a description is given of the most suitable experimental procedure for the injection of the reagents HF and $K_2H_2Sb_2O_7$ into the aquifer. The retention capacity of the installed barrier for Sr is also discussed in relation to its significance for environmental safety at reprocessing plants. (auth)

16805 MOVEMENT OF RADIONUCLIDES IN THE AERATED ZONE. Dlouhy, Z. (Nuclear Research Inst., Rez, Czechoslovakia). pp 241-9 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

Samples of selected natural materials were examined in detail, on a laboratory scale, under both batch and dynamic conditions and the results obtained were used to predict the behavior of selected radionuclides in the field experiments. Representative samples of Casaccia soil and Casaccia tuff (CNEN, Italy) were chosen. The main criteria to evaluate their retention of Cs, Sr, Ce, Zr, Nb, and Ru were the distribution coefficients (K_d), dispersion coefficients, porosity and permeability. Some variations of these factors were studied under laboratory conditions, i.e., the variation of K_d with pH, time, and composition of the eluting solution. However, the main effort was directed to elution experiments, which, by the application of chromatographic equations, K_d and dispersion coefficient data, provided a basis for a theoretical curve showing the radionuclide distribution in the profile. The field experiments with selected radionuclides were carried out with small cribs excavated in the ground. After several cubic meters of water had been passed through the contaminated bottom of the crib the distribution of the radionuclide was analyzed throughout the profile. In addition, experiments were made with Cs and Sr in cribs filled with a layer of the tuff. The results showed a small difference between the theoretical and experimental distributions of all the radionuclides studied. Dispersion was generally greater under field conditions and the peak of radioactivity moved faster than expected, perhaps due to a higher humic-acid content. Nevertheless, even a rough prediction of the important fission-product behavior is most valuable in the selection of a suitable disposal site. (auth)

16806 EXPERIMENTAL STORAGE OF RADIOACTIVE WASTE AT SHALLOW DEPTH. Gailledreau, C.; Berlin, C. (Centre d'Etudes Nucleaires, Cadarache, France). pp 251-9 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967. (In French).

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Solid radioactive waste may be stored safely in the soil at shallow depths provided it lies above the water table and is protected from any significant infiltration by rainwater. A facility was constructed whereby the buried waste is covered by a polyethylene umbrella with a surrounding drain. The walls and bottom of the waste pit itself are highly permeable and are made of large pebbles to catch any ground water diffusing laterally into the facility. Water from the drain surrounding the umbrella and from the bottom drain flows by gravity towards a nearby ravine, the bottom drain passing into a monitoring sump. To reduce water condensation beneath the umbrella, the latter is covered by a mound of earth 30 to 50 cm thick with turf on top, which acts as a thermal screen. The amount of water in the area in which the waste is stored—20 mCi of fission products—and in the soil outside the facility is measured with a neutron moisture gage, and the results of these measurements are given. It has been found that the volume filled by the waste constantly remains dry. The results of monitoring the drain sump are also quoted. Finally, an estimate of the cost price of such storage per unit volume is given. (auth)

16807 UNITED STATES ATOMIC ENERGY COMMISSION INTERIM RADIOACTIVE WASTE BURIAL PROGRAM. Lenneman, W. L. (Atomic Energy Commission, Washington, D. C.). pp 261-300 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

Early in 1960, the United States Atomic Energy Commission (AEC) provided industry with radioactive waste disposal services in strategic locations within the United States. It announced that radioactive waste burial grounds at Oak Ridge, Tennessee, and the National Reactor Testing Station, Idaho, would be made available to AEC licensees for the disposal of solid radioactive wastes. For the next three years, the AEC had an interim radioactive waste program which was terminated when privately operated grounds, serving regional areas of the country, became available. The administrative processes, treatment, and procedures of a national radioactive waste burial program are described. All AEC radioactive waste burial grounds and operations were coordinated and a common reporting system and administrative controls were established for radioactive waste burials. Procedures were established for handling off-site and licensee waste shipments and deliveries to the interim burial grounds. Complete records were maintained of the disposition of the 7.2 million cubic feet (203 thousand cubic meters) of AEC and licensee generated waste which was buried during the three-year period. Radioactive waste classification, handling procedures, reporting forms and systems, administrative controls, and numerous problems and their resolutions are presented and discussed. Waste burial data and burial costs for the program are given. Post-1963 United States radioactive waste burial data and information through 1966 also are included. (auth)

16808 CHARACTERIZATION OF TROMBAY SOILS FOR DISPOSAL OF RADIOACTIVE WASTE. Godse, V. B.; Mohan, A. L.; Singh, Mahesh; Amalraj, R. V.; Thomas, K. T. (Bhabha Atomic Research Centre, Trombay, India). pp 301-15 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

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The Bhabha Atomic Research Center is situated on an island about 5 km east of Bombay Island, from which it is separated by the Bombay harbor bay. The area consists of typical horizontal basaltic flows covered by 1 to 2 m of loose soil followed by weathered rock to a depth of 9 to 10 m. The radioactive waste disposal/storage area is located at the foot of Trombay hill between the contours of 25 ft and 90 ft and covers an area of 50,000 m^2. Laboratory and field studies were carried out to characterize the Trombay soils and ground water and to examine the criteria for the safe disposal of radioactive wastes. The physical and chemical properties of the soils were determined to evaluate their retention and leaching properties for radionuclides of interest. The soil covering consists of silty clay to a clayey type of soil with a base exchange capacity of 34 to 76 meq/100 g. The relative velocity factors for the radionuclides of interest have been evaluated in the laboratory with respect to the ground-water velocity in the area. Field studies were conducted by establishing a series of bore-holes in a grid pattern, and field permeability was studied to determine the ground-water velocity in the area. Tracer experiments were also conducted for the rate and direction of ground-water movement. An experimental study of direct discharge of solid waste from a chemical plant to the soil environment indicated that there was slight leaching of activity immediately after the monsoon. In view of the prevailing geological, hydrological and climatic conditions at Trombay area, the general policy adopted for ground disposal is to contain the radioactive wastes in solid form with adequate monitoring and environmental surveillance. (auth)

16809 SELECTION CRITERIA FOR GROUND DISPOSAL SITES FOR SOLID RADIOACTIVE WASTE IN HIGHLY POPULATED AREAS. Giannotti, G. P.; Mittempergher, M.; Sidoti, G. (CNEN, Casaccia, Italy). pp 319-28 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

In contrast to deep disposal of radioactive waste, which ensures virtual isolation, shallow disposal is influenced directly by possible interaction of the waste with natural waters and indirectly by a number of other environmental factors. In examining Italy for potential waste burial sites, various criteria were studied and priority allotted to certain of these. The six most important criteria for consideration are: geology, hydrology, vulcanology, seismicity, climatic details and the population density associated with a proposed site. In addition, other factors that may need to be considered include economy, pedology, soil utilization, bathymetry, ecology and ground organization. It is believed that the investigations undertaken in Italy may be applicable to other countries with high population densities. (auth)

16810 PLANS FOR LONG-TERM STORAGE OF LOW- AND MEDIUM-LEVEL RADIOACTIVE WASTES IN SWITZERLAND. Graf, P. (Motor-Columbus Ltd., Consulting Engineers, Baden, Switzerland); Rottenberg, W. pp 329-41 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

Extensive use of ground water as the principal drinking-water source and the relatively high population density in most parts of the country make the problem of radioactive waste disposal extremely difficult in Switzerland. The growing demand for drinking water necessitates augmenting the natural ground water with surface water from rivers, or the domestic use of water from lakes; protection of the surface water from radioactive pollution is therefore strictly enforced. No liquid, suspect contaminated waste is authorized to be released into the ground. The radioactive concentration of effluents to be released is not allowed to exceed the maximum permissible concentrations for drinking water (ICRP). The relatively low flow rates of the rivers in Switzerland therefore allow only very low amounts of activity to be disposed of in liquid form. The solid and solidified low-level radioactive wastes originating from large nuclear facilities (nuclear research centers and power plants) are compressed and packed in standard steel drums and are at present stored ad interim in weather-proof waste storage areas on the nuclear plant sites. For the scattered producers of small quantities of low-level waste (hospitals, universities, radioisotope laboratories, etc.), temporary storage facilities were made available under the responsibility of the Federal Office for Public Health. The increasing amounts of intermediate-level radioactive solid wastes at the Reactor Research Center (EIR) necessitate the use of prefabricated concrete-shielded waste containers, which will be stored temporarily in an open air concrete vault structure on site. There are plans to build a permanent centralized waste-storage building, under the responsibility of the Federal Office for Public Health, for packed low-level radioactive solids originating from the producers of relatively small waste quantities, and a storage structure for low- and intermediate-level radioactive solid wastes generated in the Reactor Research Center and the nuclear power plants currently under construction or planned in the same region. Plant layouts of these permanent storage facilities and the waste packing methods to be applied are discussed. It is hoped that when the technology of incineration is more advanced, it will prove to be effective for additional volume reduction of low-level solid wastes in the near future. The general opinion of the public and local authorities is widely opposed to radioactive waste disposal, which makes the realization of these waste storage projects very difficult. (auth)

16811 DISTRIBUTION AND CIRCULATION OF BARIUM, RUBIDIUM, STRONTIUM, AND CAESIUM IN NATURAL WATERS AROUND THE CASACCIA NUCLEAR CENTRE. Dall'aglio, M.; Giannotti, G. (CNEN, Casaccia, Italy). pp 343-66 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

In order to study the problem of ground disposal for radioactive waste it is necessary to have complete knowledge of the local hydrology with particular reference to the various hydrological conditions and the chemical and physical environments that may be affected by the natural waters. It is also important to understand the factors that regulate the movement of radioactive waste in the environment. Since the most hazardous constituents of radioactive wastes are Sr and Cs, the natural occurrence of these elements was examined both in surface and ground waters throughout the 160 km^2 area surrounding the Casaccia Nuclear Research Center. This area has a variety of hydrological and geochemical environments, the study of which has provided information on the migration and regions of reconcentration of the elements examined. The research was also extended to include Ba and Rb because of the geochemical similarity between these elements and Sr and Cs. (auth)

16812 ASSESSMENT OF THE VARIOUS FACTORS GOVERNING THE SITING OF A RADIOACTIVE WASTE BURIAL GROUND FOR THE MEXICAN NATIONAL NUCLEAR ENERGY COMMISSION. Vazquez Barete, M.; Bravo Suarez, E. (Comision Nacional de Energia Nuclear, Mexico). pp 367-82 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967. (In Spanish).

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

Various regions in the neighborhood of Mexico City were studied with a view to finding suitable sites for the installation of a radioactive waste burial ground. Each region was assessed from the viewpoints of lines of communication, rainfall, proximity to population centers, prevailing winds and their velocity, liability to earthquakes, sub-soil structure, fertility, and in general all the factors which might make it desirable or undesirable for habitation in the near future. Other important factors studied were the possibility of acquiring the sites, their size and proximity to common land which might be considered as affected, and certain legal aspects which might affect the land in the planning stage, such as rights of way, restrictions on use, and possible expressway construction. After assessment of the various technical, economic, administrative and legal aspects and consideration of the possible dispersal of radioactive elements into various media (atmosphere, water, soil, etc.), the sites most suitable for the radioactive waste burial ground were proposed, the conservation of natural resources and above all public safety being borne in mind. (auth)

16813 COMPARATIVE STUDY OF THE BEHAVIOR IN SOIL OF RADIOACTIVE WASTE SOLIDIFIED BY VARIOUS PROCESSES. Rodier, J.; Niezborala, F.; Marichal, M. (CEA, Marcoule, France). pp 383-400 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967. (In French).

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The processing of radioactive waste has given rise to a certain number of intensive studies of industrial projects. Vitrification, encapsulation in bitumen and solidification in cement constitute three solutions to the problem of storing radioactive waste. A comparative study is made of the behavior of waste processed by these three methods in a specific soil and under particular atmospheric conditions. (auth)

16814 PERMANENT DISPOSAL BY BURIAL OF HIGHLY RADIOACTIVE WASTES INCORPORATED INTO GLASS. Merritt, W. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 403-8 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

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A method was developed at Chalk River for incorporating high-level fission product wastes from nuclear fuel processing into glass blocks for ultimate disposal. Nitric acid solutions of fission products were mixed with nepheline-syenite and lime in crucibles and fired in a kiln to a temperature of 1350°C to form a glass with high resistance to leaching. Two test disposals of glass blocks were made into the ground below the water table. The first, in August 1958, contained about 300 Ci in 25 blocks of a highly resistant glass. The second, in May 1960, contained about 1100 Ci in 25 blocks of a less resistant formulation. Monitoring of the two tests has continued for eight and six years respectively. A soil sampling program indicated that the leaching rate tended to decrease with time and is now less than 10^{-10} g/cm^2 per day, or two orders of magnitude lower than that predicted from laboratory leaching tests. The results indicate that the method is suitable for permanent disposal of high-level nuclear wastes and that the blocks could be buried unprotected in a controlled area, even in saturated sand of low exchange capacity. Burial above the saturated zone in an arid region would result in even less release of radioactivity from the glass. (auth)

16815 STORAGE OF RADIOACTIVE SOLIDS IN UNDERGROUND FACILITIES: CURRENT ICPP PRACTICES AND FUTURE CONCEPTS. Wheeler, B. R.; Dickey, B. R.; Lohse, G. E.; Black, D. E.; Rhodes, D. W.; Buckham, J. A. (Idaho Nuclear Corp., Idaho Falls). pp 421-40 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

High-activity granular solids are stored in stainless-steel bins inside a buried concrete vault at the Idaho Chemical Processing Plant for about \$1500/m^3. Currently, the solids originate from fluidized bed calcination of aged acidic aluminum nitrate solutions with an activity of up to 6 Ci/l. Storage of solid waste is safer and more economical than the storage of an equivalent volume of liquid waste. Liquid storage in underground stainless steel tanks with a volume of 1100 m^3 at ICPP costs about \$13200 per volume of solution equivalent to 1 m^3 of solids, and the costs for converting to solids are about \$6600/m^3. Two different types of solids storage bins are in use at ICPP. The original set of bins was designed to accommodate material generating 1100 kcal/h m^3 at a maximum temperature of 400°C; these bins now contain about 210 m^3 of solids formed from calcining over 1920 m^3 of waste solution. The second set of bins consists of seven 3.65-m dia. cylinders inside a vented concrete vault; these bins were designed on the basis of a solids heat generation rate of 150 kcal/h m^3 and a maximum temperature of 700°C, assuming natural convection and neglecting heat transfer to the soil. Laboratory work shows that no fission products will be released from the stored solids and safety aspects of storage at even higher temperatures are being studied to reduce further the expense of solids storage. An appreciable reduction in costs for solids storage facilities could be realized by omitting the concrete vault and burying bins directly in the soil. To evaluate this concept, in which all decay heat would be dissipated directly to the soil, mathematical models have been developed for predicting temperatures within the surrounding bins of radioactive solids. The developed mathematical models can be used to predict both the steady-state and transient temperatures by knowing thermal conductivity and specific heat of the solids and surrounding soil, the rate of heat generation within the bin, and the dimensions of the bin. Temperatures, calculated on the basis of an appropriate model, compared favorably with experimentally measured temperatures. (auth)

16816 RESEARCH ON THE PERMANENT DISPOSAL OF RADIOACTIVE WASTES IN SALT FORMATIONS IN THE FEDERAL REPUBLIC OF GERMANY. Schwibach, J. (Federal Ministry for Scientific Research, Bad Godesberg, Ger.). pp 465-77 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

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In the Federal Republic of Germany, as well as in other densely populated European countries, the method of burying radioactive wastes in shallow ground could not be adopted because of the intensive land utilization, apprehensions on the part of the public and the need to preserve the natural water resources. Only in exceptional cases may radioactive wastes be disposed of in the same way as conventional refuse. For the permanent disposal of the bulk of radioactive wastes, which are packaged and currently stored in private or state-owned interim storage halls, scientific bodies in the Federal Republic have recommended that such wastes be stored in deep salt formations. Research and development of this method have been entrusted by the Federal Ministry for Scientific Research to the Gesellschaft für Strahlenforschung, Munich, together with the Gesellschaft für Kernforschung, Karlsruhe, and the Bundesanstalt für Bodenforschung, Hanover, and other scientific institutes. The first step was the signing of a research contract between the Gesellschaft für Strahlenforschung and Euratom to establish a cavity for low-level radioactive wastes in a salt dome in the north-west of the Federal Republic. The abandoned Asse salt mine was then purchased by the Federal Government. The research which is under way there or planned for the near future is reviewed. In particular, questions of the inherent safety of salt storage of high-level wastes are discussed. (auth)

16817 PROJECT FOR STORING RADIOACTIVE WASTES IN A SALT CAVITY. Krause, H.; Ramdohr, H.; Schuchardt, M. C. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). pp 479-94 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

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The solution method of creating a cavity in a salt dome is described. The mechanism for introduction of the radioactive waste into the cavity and the problems involved are explained (bore-hole diameter, method of introduction, etc.). Economic considerations are presented for a cavity of 10,000 m^3 and the influence on the cost of parameters such as depth and diameter of the bore-hole and size of the cavity is investigated. (auth)

16818 RADIOACTIVE WASTE STORAGE IN CAVITIES FORMED BY DISSOLUTION IN SALT: PRELIMINARY STUDIES. Barbreau, A.; Escalier des Orres, P. (Centre d'Etudes Nucleaires, Saclay, France). pp 495-508 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967. (In French).

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The possibilities of storing radioactive waste in cavities formed by dissolution in salt deposits are described. This method is particularly attractive because of the characteristics of rock salt and the degree of safety offered. The geological and technological conditions and the safety criteria are described. The salt deposit must be thick enough to enable a cavity to be formed, but if thick deposits are not available, diapiric structures would seem to be most suitable. The method of forming cavities by dissolution, their optimum shape and size and the problems posed by salt dissolution are discussed showing that the content of insolubles must be relatively low. The cavity should possess good stability, and for this purpose should preferably be conical in form. In order to ensure safe storage, it is necessary to choose a formation with adequate overburden and permanent isolation from gound water outside the salt mass. The areas of metropolitan France suitable for such storage are being surveyed. (auth)

16819 GEO-SCIENTIFIC INVESTIGATIONS IN THE ASSE II SALT MINE. Kuehn, K. (Institut fuer Tieflagerung Clausthal-Zellerfeld der Gesellschaft fuer Strahlenforschung, Munich). pp 509-18 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

In the radioactive waste disposal program of the Federal Republic of Germany, the abandoned salt-mine at Asse, near Wolfenbüttel in lower Saxony, is to be used for storage of the wastes. This mine now belongs to the Gesellschaft für Strahlenforschung München. The Asse salt appears in an elongated salt dome about 8 km long. The country rock is formed by Triassic sandstone and limestone. Rock mechanical investigations were performed by hydraulic press on series of test models in the form of cubes and on room and pillar models. The cube compressive strength of Asse rock salt is about 400 kp/cm^2. The load-bearing capacity of the different pillars varies from 350 to 420 kp/cm^2. To compare the laboratory results with the conditions in the mine, in situ investigations are being carried out in the mine. In addition to the rock mechanical investigations, detailed mine-surveying measurements have been carried out to detect possible movement of the salt. Since most of the rooms were excavated ten to fifty years ago, no significant movements have been observed. In general, the movements of the walls are relatively large immediately after the driving of the rooms, but they soon die down asymptotically. The mine-surveying measurements are done not only in the rooms but also in the drifts. The results are the same here. To study the behavior of the salt at high temperatures, a temperature test field was installed in the mine. The rock salt was electrically heated to a temperature of about 400°C. Due to the specific thermal conductivity of the salt the temperatures decrease rapidly from the heaters to the borders of the test field. At this test field precise mine-surveying is also done to check floor lifting. Other tests have just been started to examine the compressive strength of rock salt by triaxial hydraulic press at high temperatures. (auth)

16820 EXPERIMENTAL STORAGE OF RADIOACTIVE WASTES IN THE ASSE II SALT MINE. Krause, H. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.); Ramdohr, H.; Boehme, G.; Albrecht, E. pp 519-31 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

The storage of radioactive wastes in salt formations seems to be one of the most promising methods of ultimate disposal in the Federal Republic of Germany. To carry out experiments on this method and to store actual wastes, the abandoned Asse II salt mine near Braunschweig (Lower Saxony) was purchased. After termination of the present repair work the first low- to intermediate-level wastes will be introduced. In addition, preparations are being made for storage of solidified high-level wastes and spent nuclear fuels within an experimental program. The Asse II salt mine, the installations for the storage of low-level wastes and the plans for storing high-level wastes are described. (auth)

16821 COOLING OF HIGH-LEVEL RADIOACTIVE WASTES IN MINES BY AIR VENTILATION. Kappelmeyer, O.; Mufti, I. (Bundesanstalt fuer Bodenforschung, Hanover). pp 533-47 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

If high-level radioactive wastes are deposited underground, high temperatures may develop. If the waste is deposited in a mine, the temperature rise can be controlled by air cooling. The processes of air ventilation and the circulation of the heated air through the mine are investigated. A portion of the heat absorbed by the air on its way through the mine is dissipated through the walls of the galleries into a large volume of rock; the remainder is dissipated to the atmosphere. All these thermal phenomena involved are non-stationary. The theory of temperature rise inside and outside rock cavities containing radioactive waste is discussed. Diagrams are presented for the determination of the temperature field as a function of space and time; they are valid for wastes of arbitrary radioactive composition, for the entire range of thermal constants of the rocks as well as for cavities of various sizes and shapes. In addition, the theory of heat transfer between galleries in the mines and the surrounding rocks is applied. The entire theoretical treatment is based on dimensionless quantities, consequently the diagrams based on it have a wide application. As an example, a certain quantity of waste of known radioactive composition is considered for storage in the Asse salt mine. The temperature rise and the amount of air needed to maintain the temperatures below a given limit are calculated. To determine the original geothermal field prevailing before deposition, temperature measurements were carried out in the Asse mine. Finally, it is shown that the temperature rise resulting from the deposition of radioactive waste underground is limited to small zones around the cavities and does not influence a greater geological complex such as a salt dome. (auth)

16822 PROGRESS IN THE UNITED STATES OF AMERICA TOWARD DEEP-WELL DISPOSAL OF LIQUID AND GASEOUS RADIOACTIVE WASTES. Clebsch, A. Jr.; Baltz, E. H. (Geological Survey, Washington, D. C.). pp 591-605 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

The basic technology for deep-well disposal of liquid wastes in the geologic sub-surface has been developed and used by the petroleum industry for disposal of oil-field brines and adapted by the chemical industry for disposal of certain noxious wastes. Requirements for disposal of radioactive wastes are more stringent than for most other industrial wastes. These include a more complete understanding of physical and geologic characteristics of the disposal reservoir, effects of chemical reactions between waste and reservoir rock, and hydraulic effects on long-term injection on rate and direction of mass transport and integrity of geologic units bounding the disposal reservoir. Studies to evaluate the deep-well method specifically for disposal of radioactive wastes, plus information on other ground-disposal practices and on deep disposal of other industrial wastes, indicate that the method itself is technically feasible. However, deep-well disposal is not feasible at many existing waste-generating sites because of unsuitable geologic environments. Future plants could utilize the method if geologic and hydrologic conditions were favorable. Gas-injection research has considered disposal of relatively large volumes of fission-product gases in a short period of time into either water-saturated sedimentary rocks or unsaturated rocks. Mathematical models of gas flow, definition of the problems of dispersion, laboratory studies of gas sorption on earth materials, the role of barometric changes in bringing injected gases back into the atmosphere, engineering and economic evaluations, and field tests of the method have all been part of the program. As a safeguard for the rapid disposal of fission-product gases and other gases after a highly improbable major reactor accident, the injection method is severely limited in saturated rocks by dependence on favorable hydrogeologic conditions, the need to prepare the disposal reservoir in advance and maintain it by continuous injection of air, and the cost. The prospects are better for using the method in unsaturated rocks and for routine disposal of waste gases that can be separated as a low-volume stream. (auth)

16823 POSSIBILITIES OF INJECTING RADIOACTIVE WASTES INTO DEEP, PERMEABLE GEOLOGICAL FORMATIONS. Barbreau, A. (Centre d'Etudes Nucleaires, Saclay, France). pp 607-20 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967. (In French).

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

The injection of radioactive effluents into deep, permeable geological formations can be a very satisfactory method of disposing of certain wastes, particularly as experience in using this method in the petroleum industry and with other industrial wastes is already available. The different factors involved in the economic and safe injection of waste, with particular reference to injection techniques and the conditions of containment of effluents are discussed. The latter depends on the nature and structure of the soul and the hydrodynamic characteristics of deep water bodies. The possibility of entraining effluents in certain structures is considered. The slowness of circulation of certain deep water bodies is an important safety factor. Because of the size of the strata which can be used as a reservoir, it may be possible to inject large quantities of waste. It will be necessary to carry out further research on a number of insufficiently explored aspects of the problem. In France the geological structures which may prove suitable for this type of waste storage are being surveyed. (auth)

16824 EXPERIMENTAL STUDY OF THE HIGH-PRESSURE INJECTION OF RADIOACTIVE EFFLUENTS INTO FRACTURED GEOLOGICAL LAYERS. Capitant, B.; Grison, G.; Leveque, P. (Bureau de Recherches Geologiques et Minieres, Paris). pp 621-51 of Disposal of Radioactive Wastes into the Ground. Vienna, International Atomic Energy Agency, 1967. (In French).

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria. See STI/PUB-156; CONF-670512.

Radioactive effluents can be satisfactorily stored by injecting them, in the form of a cement or clay grout, into closed geological structures. An attempt has been made to reproduce in a superficial geological formation some of the effects of fracturing at depth. High-pressure injection tests were carried out with inert elements in surface layers. The work consisted of the high-pressure injection of various types of grout in weathered and fractured granites and a subsequent examination of their movements by excavating trenches and a study of the radioactive anion and cation retention by the grouts, and by the ground into which they are injected, with the following isotopes: ^{45}Ca, ^{89}Sr, ^{204}Tl, ^{95}Zr, and ^{106}Ru. A study was made of the main parameters in the adsorption mechanism, i.e., the petrographic nature of the soil, the grain size and shape of the voids and fractures, the nature and concentration of the radioactive ion and the composition of the grouts. The results obtained, together with further application of the method, using well-known mineral-oil formations as specific examples are described. (auth)

16825 FUSION OF RADIOACTIVE CONCENTRATES IN GLASSES OR CERAMICS. PART 2. SUITABILITY INVESTIGATIONS OF LOOSE MINERALS FROM NATIVE DEPOSITS. Sachse, G.; Rosenberger, H. (Zentralinstitut fuer Kernforschung, Dresden. Institut fuer Angewandte Mineralogie, Dresden). Kernenergie, 10: 344-9(Nov. 1967). (In German).

The properties of native loose minerals are described, especially of plastic clays of various composition and utilization, of the decomposition products of syenite, of a paleozoic slate, and of a glaze loam. The sintering and melting properties, grain structure, gel formation with acids, and the manufacturing of hydrolytically resistant ceramics from the loose minerals studied with inactive additions were investigated. The selection of raw materials suitable for the solidification of radioactive concentrates provided for secular disposal is considered. For this purpose, the fraction of the activity of the radioactive sinter products extractable by distilled water was determined by using a simple comparison technique. Among the 30 raw materials, 14 of which are being studied in detail, four samples showed good or very good properties with respect to both melting behavior and retention. (auth)

16826 GEOLOGICAL STUDIES ON THE POSSIBILITIES OF STORING RADIOACTIVE WASTES IN THE CSSR. Zajic, J. (Institut fuer Ingenieur-Geologische und Hydrogeologische Forschung, Prague). Kernenergie, 10: 312-18(Oct. 1967). (In German).

Investigations on the utilization of geologic formations for the disposal of radioactive wastes in the C.S.S.R. are described. The possibilities of storage in an abandoned mine (chalk formation) or in an isolated nonproductive petroleum structure (neogen) are described. Finally, the state of studies on the utilization of the sorptive properties of loose rocks and soils for purifying waste liquids are discussed. (auth)

Vacuum Engineering

16827 EFFICIENT BAFFLE FOR REDUCING STRAY CURRENTS IN SPUTTER-ION PUMP VACUUM CHAMBERS. Goff, Robert F. (Bendix Research Labs., Southfield, Michigan). Rev. Sci. Instrum., 39: 259-61(1968).

A baffle is described which is used to reduce stray currents in sputter-ion pump vacuum chambers. The baffle has reduced stray electron currents by a factor of 100 over a wide range of pressures. Small parts cannot be accidentally dropped into the pump. The baffle consists of a screen combined with a complete optical system. (F.S.)

16828 HANDBOOK OF MATERIALS AND TECHNIQUES FOR VACUUM DEVICES. Kohl, Walter H. New York, Reinhold Publishing Corp., 1967. 635p. $30.00.

Descriptions and related performance and property data of all materials and techniques used in the manufacture of modern vacuum devices are presented in handbook form. Included are metals and alloys used in these products, as well as nonmetallic materials such as glass, ceramics, mica, and carbon. The techniques used in joining metals both to each other and to glass and ceramics are also discussed. (R.C.K.)

16829 COLLOQUE INTERNATIONAL SUR L'ULTRA-VIDE, PARIS, 28-30 Juin 1967. (International Conference on Ultra-High Vacuum, Paris, June 28-30, 1967). Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. 200p. (In Several Languages). (CONF-670638). DTIE.

Forty papers were presented at the conference. Separate abstracts were prepared for twenty-six. One paper previously appeared in NSA; for abstract see 22: 8411. The remaining papers contain information on high vacuum equipment and methods not within scope of NSA. (R.C.K.)

For abstracts of individual papers see: 16830–16855.

16830 TESTS OF PUMPS, MASS FILTERS, He DETECTORS AND FAIL SAFE VACUUM COMPONENTS FOR THE OMNITRON ACCELERATOR. Milleron, M. N. (Univ. of California, Berkeley). pp 5 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967.

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

The OMNITRON, a synchrotron capable of delivering a smooth current (~10^{12} ions/sec) of any ionized nucleus at energies up to 500 MeV/N (1.5 GeV for protons), is described. Tests of 3° to 20°K cryopumping are compared to tests of sputterion, orbitron, turbomolecular and vapor jet systems. Recovery from simulated accidents and pumping of H_2 and He gas loads is discussed. The results of tests of fail safe over pressure triggers, fast closing valves, porous metal traps and acoustic delay lines are also discussed. Four brands of commercial He mass spectrometer leak detector heads are compared simultaneously, and tests of commercial quadrupole and monopole mass filters are given. (auth)

16831 ON THE MODULATION CHARACTERISTIC OF A BAYARD–ALPERT IONIZATION GAGE. van Oostrom, A. (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). pp 7-11 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967.

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

Modulation with the grid end-caps of a Bayard–Alpert ionization gage (BAG) is discussed. Argon and oxygen are used to investigate the modulation characteristics. The influence of modulation on ions produced in the gas phase can be measured in Ar as the grid surface can be kept free of adsorption. The influence of electron impact on the adsorbed oxygen was also studied. (F.S.)

16832 MEASUREMENTS WITH BAYARD–ALPERT GAGES WITH LOW X-RAY LIMIT. Bernardet, Henri; Shaw, Maria (Societe Generale du Vide, Choisy-le-Roi, France). pp 19-29 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

The x-ray limit of the Groszkowski hidden collector gage was measured and optimum anode voltages of the gage were determined. The x-ray limit was evaluated as 5×10^{-13} torr. The effect of exterior shielding on the sensitivity was measured for the immersed model. A gage model could be defined completely independent of external perturbations. (J.S.R.)

16833 DESIGN AND EVALUATION OF A FAST RESPONSE MASS SPECTROMETER FOR RESIDUAL GAS ANALYSIS. Evans, S.; Collins, R. D. (Edwards High Vacuum, Ltd., Crawley, Sussex, Eng.). pp 37–40 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967.

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

A small sector field mass spectrometer specifically designed for residual gas analysis and incorporating a particle multiplier was developed. The spectrometer has a high intrinsic sensitivity even under fast scanning conditions. Noise and response time limitations are reduced. The main limitation is statistical noise arising from the corpuscular nature of the ion beam. At scanning rates down to 100 μsec/amu partial pressures of 10^{-10} torr may be resolved. (F.S.)

16834 PERFORMANCES OBTANINED IN ULTRAVACUUM BY A PENNING IONIC PUMP. Marechal, J. C.; Pontvianne, J. (Compagnie Generale de Telegraphie sans Fil, Paris). pp 65 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

The vacuum limit obtained by a 200 l/sec pump and the actual pumping rates obtained after stabilization in the range from 10^{-8} to 10^{-11} torr were indicated. The distribution of the different residual gases was shown. The method for the measurement of the pumping rates was described. (tr-auth)

16835 PRODUCTION OF ULTRAVACUUM BY TITANIUM DEPOSITION ON COLD SURFACES. I. SCIENTIFIC BASES. Prevot, F.; Sledziewski, Z. (EURATOM–CEA, Fontenay-aux-Roses, France). pp 67-9 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

The principal properties of titanium pumping on cold surfaces are summarized. The pumping mechanism is outlined. (J.S.R.)

16836 PRODUCTION OF ULTRAVACUUM BY TITANIUM DEPOSITION ON COLD SURFACES. II. TECHNOLOGY AND APPLICATIONS. Prevot, F.; Sledziewski, Z. (EURATOM–CEA, Fontenay-aux-Roses, France). pp 70-3 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

The necessary technology for pumping by titanium deposition on cold surface consists essentially of evaporators, cold surfaces, and auxiliary pumping. These are briefly described. The construction of a titanium pump for use with a magnetic mirror device is described. (J.S.R.)

16837 COMPARISON OF ANALYSES OF RESIDUAL GASES ABOVE A DIFFUSION PUMP IN AN ULTRAVACUUM SYSTEM (DESCRIPTION OF AN IONIC TRAP DEVICE). Sarrau, J. M. (Faculte des Sciences, Rouen). pp 81-85 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

Mass spectrometric analyses were made of the residual gases above different trap devices placed between the primary pump and the diffusion pump. The pumping ensembles studied were traps, liquid nitrogen trap, zeolite 13 X trap, and an ionic trap. The spectra obtained are given and show that the ionic trap is the most efficient. (J.S.R.)

16838 EXPERIMENTAL ENSEMBLE IN ULTRAVACUUM. Vaumoron, J. (Edwards High Vacuum, Ltd., Crawley, Sussex, Eng.). pp 91 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

An ultravacuum experimental pumping unit was developed using a pump with radial electric field and a Penning-type pump. The Penning pump has cathodes covered with drawn metal in order to improve the pumping of rare gases. This unit was designed for the study of the secondary emission in an atmosphere without contamination at pressure below 10^{-10} torr. The action of the drawn metal cathodes and the pumping characteristics were studied. The composition of the residual atmosphere obtained by using the two pumps separately and in conjunction was determined. (tr-auth)

16839 INDUSTRIAL ULTRAVACUUM WITH THE AID OF A DOUBLE-CHAMBERED FRAME. Bailleul-Langlais, J. (Coprim RTC, Suresnes, France). pp 93-7 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

A frame permitting the production of 10^{-10} torr vacuum in 2 to 3 hrs is described. This performance is due to a simple and rapid start-up which was conceived using a double-chambered system and mobile valve, and an ultravacuum pumping technique with very high speed using a cryotitanium pump. The known anticontamination techniques were used to the maximum for this frame. (tr-auth)

16840 THE SYSTEMATIC STUDY WITH QUADRIPOLAR MASS SPECTROMETER STUDY OF A TITANIUM EVAPORATION SYSTEM HAS LED TO THE DEVELOPMENT OF A NEW PUMP EXTENDING THE APPLICATIONS OF VACUUM PROPER TO THE REGION OF SIGNIFICANT DEGASSING PHENOMENA. Varon, M. A.; Desforges, M. M. (Societe Francaise d'Ultra-Vide, Riber, France). pp 99-103 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

The systematic study made on a titanium evaporation system at vacuum of approximately 10^{-11} torr is briefly outlined. The spectra and variation of total pressure of the system were determined which show the necessity of a liquid nitrogen trap. The system was studied under conditions of leak up to 10^{-3} torr and power on the order of a kw. The equilibrium pressures are very sensitive to the use of titanium filaments. A temperature increase observed led to the increase of the dimensions of the ionic pump associated with the second titanium pump with a getter metal wire evaporated by Joule effect. The use of a titanium source constituted by a titanium rod bombarded by an electron beam was satisfactory. The sublimators used are described. (J.S.R.)

16841 DETERMINATION OF A RANGE OF TURBOMOLECULAR PUMPS. Garnier, H.; Rousseau, M.; Rubet, L. (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Suresnes, France). pp 104-7 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

A method was developed for predetermining the characteristics of a turbomolecular pump beginning with cells of an isolated disc. The method was verified by comparison with experimental results. With the equations derived, it is possible to dimension a turbomolecular pump according to the performance desired. (J.S.R.)

16842 SMALL TURBOMOLECULAR PUMP OF RECENT CONSTRUCTION. Becker, M. W. (Arthur Pfeiffer Hochvakuumtechnik, GmbH, Wetzlar, Ger.). pp 109-14 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In German).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

The design and construction of a turbomolecular pump with peripheral velocity of 140 m/sec and suction capacity of 70 l/sec was described. The final vacuum obtainable with the small dimensioned pump is below 10^{-9} torr. (J.S.R.)

16843 CHARACTERISTICS OF THE METALLIC JOINT WITH INDUCED ELASTICITY. Bernard, Bernard; Bernard, Rene; Monne, Maxime (Institut National des Sciences Appliquees de Lyon). pp 121-5 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

The conditions for the use of the joint with induced elasticity are described in detail. The stability of the joint with respect to leakage and time wear was verified. The joint can be used from temperatures of −193 to 450°C. The resistance of the joint to counter-pressure and to environmental stresses is reported. The possibility of the re-use of the joint is discussed. (J.S.R.)

16844 TECHNIQUES OF DOUBLE GASKET SEALS FOR QUICK-CYCLE ULTRAHIGH VACUUM APPLICATIONS. de Csernatony, L.; Crawley, D. J. (Edwards Vacuum Components Ltd., Crawley, Sussex, Eng.). pp 127-31 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967.

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

Experiments were performed on a ultrahigh vacuum (UHV) chamber having a large flange suitable for either double "O" rings or metal seals to determine the advantages of double "O" ring seals over metal seals. A vacuum of 10^{-10} torr can readily be achieved with double Viton "O" ring seals after only a few hours bakeout. An initial conditioning run to clean the "O" ring is necessary if the chamber or "O" ring is kept under vacuum when not in use. Assembling and dismantling are simple. Since most of the residuals are noncondensable at liquid N temperature, contamination is governed by pumping speed. With a liquid He cryopump, all residuals were beyond detection. (F.S.)

16845 BAFFLES FOR AN ULTRAHIGH VACUUM SYSTEM. Gregg, A. H.; Reid, D. J. (Trinity Coll., Dublin). pp 137 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967.

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

A standard evaporating plant was converted into an ultrahigh vacuum system. Difficulties are discussed with special references to the problem of reducing to a minimum the back diffusion of oil molecules. The final system consists of a conventional chevron baffle machined from stainless steel in series with a multi plate baffle which is optically dense and has a long creep path. The baffles are coated with a Ti film. The increased pumping speed of the Ti film more than compensates for the speed reduction produced by the baffling of the oil diffusion pump. Final pressures are less than 10^{-10} torr and have been maintained for weeks by daily evaporation of Ti for one min. It is possible to cycle from atmospheric pressure in less than 48 hr with a bakeout temperature of 350°C. (F.S.)

16846 TITANIUM WIRE ADAPTED FOR SUBLIMATION PUMPS DESIGNED TO WORK IN ULTRAVACUUM. Biguinet, C. (Compagnie Generale de Telegraphie sans Fil, Paris); Schroff, A. M.; Mathiez, Ph.; Borossay, J. pp 139-41 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

In order to obtain very low pressures with an ionic pump, it is necessary to have a very high purity titanium sublimator having a very low degassing rate. A procedure for the fabrication of titanium wire for a sublimation pump is described. It is based on the pyrolytic deposition of titanium on a tungsten support. The thermal contact between the tungsten support and the titanium deposit is excellent. (J.S.R.)

16847 STUDY OF THE DEGASSING OF MATERIALS AT VERY LOW PRESSURE. Thibault, J. J.; Roussel, J.; Jourdan, M. (Centre d'Etudes Cryogeniques, Sassenage, France). pp 143-6 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

The degassing rates of stainless steel ZeCN18-8, pure copper, and the copper alloys Electral CRM16 and Inoryda III Cryogenique were measured. The experimental method was that used by Oatley and by Henry. The degassing rates obtained were 2×10^{-12}, 2×10^{-12}, 10^{-12}, and 1.5×10^{-11} torr l/sec/cm^2, respectively. (J.S.R.)

16848 TRAPPING OF VARPORS IN AN ULTRAVACUUM COLUMN. Doucet, H. (Ecole Polytechnique, Paris); Richardt, A. pp 151 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

Observations made on the injection of cesium vapor into a high vacuum enclosure are reported. The enclosure was fabricated of stainless steel with aluminum joints. It was degassed at 350°. The pumping system was constituted of two oil diffusion pumps. The pressure limit was about xx 2×10^{-8} torr without cold traps. The cesium was introduced under vacuum by breaking a glass ampule containing cesium using a nickel block. A 60° mass spectrometer was used as a gas analyzer to follow the evolution of the partial pressures. On the introduction of cesium into the enclosure the following observations were made: at low temperatures, cesium strongly reduced the partial pressure of water in the enclosure; heated to 100°C for about a minute, the cesium made water traces completely disappear and strongly reduces the partial pressure of oxygen: if air is re-introduced into the enclosure by a leak, the water vapor remains trapped and the oxygen partial pressure increased slightly; and the cesium vapor was revealed by multiply ionized cesium. (tr-auth)

16849 INFLUENCE OF THE PRE-EXHAUSTION CYCLE ON THE RESIDUAL ATMOSPHERE OF A GETTER-ION PUMPED SYSTEM. Holland, L.; Fulker, M.; Laurenson, L. (Edwards High Vacuum, Ltd., Crawley, Sussex, Eng.). pp 153-7 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967.

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

A radial electric field pump (with an air pumping speed of about 300 l/sec) was used to evacuate a system which included a large Penning pump. The system was pre-evacuated by either the sorption pumps containing a 5A molecular sieve or a rotary pump which was filled with an activated alumina trap to prevent organic fractions of the rotary pump oil back streaming into the system. After both types of pre-evacuation a getter material was evaporated from a heated filament of MoTi alloy. Enhanced partial pressure of He and Ne using sorption pumps resulted in a slow pumpdown. Faster pumpdown was obtained by pre-evacuating the system with a suitable trapped rotary pump. Effectiveness of the trap was examined. Total pressure increased but rotary pump oil contamination also increased. An activated 13X molecular sieve was found to be effective for trapping contaminant if it remained dry. (F.S.)

16850 HYDROGEN IN AN ULTRAHIGH VACUUM METAL SYSTEM PUMPED BY MEANS OF A SPUTTER ION PUMP AND A NONEVAPORABLE GETTER. Della Porta, P.; Pisani, C. (S.A.E.S., Milan). pp 161 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967.

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

Hydrogen is usually the main residual gas in metal systems pumped by means of ion pumps. The possible sources of this gas have been investigated in the region of 10^{-10} torr. The presence of a nonevaporable getter with high pumping speed for hydrogen greatly reduces the height of the hydrogen peak. Concepts such as equilibrium pressure of hydrogen in the active alloy have been recognized to be important even if the getter is at room temperature and the sorbed quantities are relatively small. (auth)

16851 RESIDUAL ATMOSPHERE ABOVE IONIC PUMPS AND ITS EVOLUTION AFTER STOPPING THE PUMP. Noe; Houyvet; Constant (CEA, Saclay, France). pp 163-6 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

The pressure rise above a titanium ionic pump after the pump is stopped was studied. The experimental results showed that a stopped titanium ionic pump desorbs the majority of the elements pumped (except oxygen), but in different forms. The heavy hydrocarbons cracked during pumping by ionization are reemitted as light hydrocarbons with 1 or 2 carbon atoms. The oxygen is practically eliminated, probably in the form of stable titanium oxide. Water vapor and carbon dioxide yield hydrogen and the light hydrocarbons. Nitrogen and the rare gases desorb regularly in their classical molecular form. (tr-auth)

16852 ULTRAHIGH VACUUM METAL DEVICE. Masiewicz, B.; Gilewicz, M. (Przemyslowy Instytut Elektroniki, Warsaw). pp 167-71 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967.

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

A pumping system was built to obtain very low pressures free from oil diffused vapors using sorption and sputter-ion pumps. The preliminary vacuum was created by 2 sorption pumps contained in metal containers which were filled with zeolites. The pumps were placed in a Dewar vessel of liquid N to create a vacuum of 10^{-2} to 10^{-3} torr which is oil-free. The ultrahigh vacuum was obtained by means of 2 cold cathode sputter-ion pumps. Pumps and valves are all of stainless steel connected by Cu gaskets. (F.S.)

16853 CHARACTERISTICS OF AN ULTRAHIGH VACUUM CHAMBER. Hayashi, C.; Tominaga, G.; Hirao, K.; Ito, I. (Japan Vacuum Engineering Co., Ltd., Yokohama). pp 175 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967.

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

A chamber was designed for the simulation of plasma in outer space. The chamber was made of highly nonmagnetic materials. A pair of Helmholz coils was employed to produce a homogeneous field for the experiment. Two 36 in. oil diffusion pumps, a titanium sublimation pump and a small sputter-ion pump were provided with a specially designed 54 in. UHV valve. Gas analysis, using a quadrupole, revealed the composition of the gases and vapors during the evacuation and the effect of nitrogen filling to 1 atm pressure. End total pressure was 10^{-8} torr when the valve was closed and the specified gas for plasma study filled to some high vacuum region for the experiment. A wide range scanning probe mechanism was also described. (auth)

16854 ULTRAHIGH VACUUM APPARATUS FOR THE INVESTIGATIONS OF SORPTION PROPERTIES OF METALLIC FILMS. Czarycki, W. (Przemyslowy Instytut Elektroniki, Warsaw). pp 177-9 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967.

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

A bakeable ultrahigh vacuum system was built for the gas sorption examination of clean metallic surfaces. The system consists of the measuring part which includes a reaction chamber and manifold joined to a calibrated leak, a pumping system, and a gas supply system. The vacuum unit is stainless steel with copper or gold plated copper gaskets. The pumping system includes an oil diffusion pump charged with silicone and a sputter-ion pump. The ionization gage, sputter-ion pump, and omegatron gage are located in the reaction chamber. (F.S.)

16855 APPLICATION OF ULTRAVACUUM TECHNIQUES TO SPECTROSCOPY IN THE FAR ULTRAVIOLET. Daude, A.; Robin, S. (Faculte des Sciences, Rennes, France). pp 181-8 of Colloque International sur l'Ultra-Vide. Paris, Societe Francaise des Ingenieurs et Techniciens du Vide, 1967. (In French).

From International Conference on Ultra High Vacuum, Paris, France. See CONF-670638.

The values of the optical constants of Al, Mg, and Tl evaporated under vacuum were determined. The techniques used to prepare foils under high vacuum are described. The solutions adopted to eliminate the absorption by the atmosphere of radiation with wavelengths below 2000 Å are discussed. The results obtained for the three metals are graphed. (J.S.R.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 16459 and 18105.

General Detectors and Monitors

Refer also to abstracts 16965 and 18123.

16856 (AE-310) CALCULATED ABSOLUTE DETECTION EFFICIENCIES OF CYLINDRICAL NaI(Tl) SCINTILLATION CRYSTALS FOR AQUEOUS SPHERICAL SOURCES. Strindehag, O.; Tollander, B. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Feb. 1968. 17p. Dep.

Calculated values of the absolute total detection efficiencies of cylindrical scintillation crystals viewing spherical sources of various sizes are presented. The calculation was carried out for 2" × 2" and 3" × 3" NaI(Tl) crystals and for sources which have the radii $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 times the crystal radius. Source-detector distances of 5 to 20 cm and gamma energies in the range 0.1 to 5 MeV were considered. The correction factor for absorption in the sample container wall and in the detector housing was derived and calculated for a practical case. (auth) (Sweden)

16857 (CEA-R-3295) DETERMINATION D'UN FLUX DE NEUTRONS DE 14 MeV PAR ACTIVATION DU CUIVRE. (Determination of a 14-MeV Neutron Flux by Copper Activation). Ameline, Daniel; Bertin, Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 28p. (In French). Dep.

Copper becomes radioactive after irradiation by 14-MeV neutrons produced by the reaction $T(d,n)^4He$. By measuring this radioactivity an evaluation of the neutron flux may be obtained. Results are presented which were obtained with a special $4\pi\beta$ detector and with conventional equipment. The number of neutrons emitted by continuous or pulsed generators were measured. The greatest error is due to the uncertainty in the cross-section value which may attain 7%. The results were in good agreement with those obtained: on the one hand by counting the α particles associated with a solid detector, and, on the other hand by counting with a bismuth activation detector for which this study has been undertaken. (auth)

16858 (CEA-R-3362) COMPTEUR 4π PROPORTIONNEL DESTINE A LA MESURE ABSOLUE D'EMETTEURS β. (4π Proportional Counter for Absolute Measurement of β-Emitters). Perolat, Jean-Pierre; Laine, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 17p. (In French). Dep.

The design and performance of a 4π counter for measuring beta activity are presented. The characteristics of this detector allow flexibility of use, particularly a possibility of adaption in a β,γ coincidence unit. (auth)

16859 (CEA-R-3371) PERTE D'ENERGIE, PARCOURS ET RALENTISSEMENT DES PARTICULES CHARGEES DANS LES DETECTEURS AU SILICIUM OU AU GERMANIUM. (Energy Loss, Range, and Stopping Power of Charged Particles in Silicon or Germanium Detectors). Picard, Jean; Souchere, Gerard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 25p. (In French). Dep.

Energy loss, range, and stopping power of charged particles in silicon and germanium solid state detectors are presented in graph and table forms. (auth)

16860 DESIGN AND FABRICATION OF A LOW-BACKGROUND-RADIATION SHIELD. Zallen, Harold; Dixon, Thomas R. (Auburn Univ., Ala.). Isotop. Radiat. Technol., 5: 207-8 (Spring 1968).

The design and fabrication details of an easily constructed lead shield for a scintillation counter are described. The shield, which houses the scintillation detector in a horizontal position, features a ball-bearing steel-rod track suspension by which the heavy shield door can be opened or closed easily by fingertip pressure. The body of the shield is made up of cast and machined lead rings to permit easy construction as well as relocation without the use of a hoist. (auth)

16861 DECOMPOSITION OF PULSE HEIGHT SPECTRA OF Ge(Li) DETECTORS. Beraud, R.; Berkes, I.; Daniere, J.; Escudie, B.; Levy, M.; Marest, G.; Rougny, R. (Institut de Physique Nucleaire, Lyon). Nucl. Instrum. Methods, 60: 219-20(Mar. 15, 1968).

An analog decomposition is used to resolve overlapping peaks in a Ge(Li) spectrum. The decomposition is verified by a numerical χ^2 test. (auth)

16862 SEMICONDUCTOR DOPING BY HIGH ENERGY 1 TO 2.5 Mev ION IMPLANTATION. Roosild, S.; Dolan, R.; Buchanan, B. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Electrochem. Soc., 115: 307-11(Mar. 1968).

The formation of junctions in silicon through the use of monoenergetic ions in the energy range from 1 to 2.5 MeV has been studied. Boron, nitrogen, and phosphorous ions were used. Results are presented on the annealing temperatures required to place these ions in substitutional states and on the distribution of these ions in the host material. A way for localized masking against the ion beam to obtain planar structures is also discussed. (auth)

16863 FAILED ELEMENT DETECTION SYSTEMS. Strindehag, O. (Aktiebolaget Atomenergi, Stockholm). Nucl. Eng., 13: 117-8(Feb. 1968).

Failed-element detection systems, developed for Swedish reactors and test loops, are described. One system utilizes a beta-sensitive fission gas detector. Other systems discussed include Cherenkov detectors and scintillation detectors for hard gamma radiation. (W.H.K.)

16864 CORRECTION FOR RESOLVING-POWER EFFECTS IN ENERGY FOR SCINTILLATION COUNTERS FOR RECOIL DEUTERON SPECTRA FROM NEUTRON IMPACT AT 14 TO 2.7 MeV. Chamayou, J. M.; Arcangeli, R. (Faculte des Sciences, Toulouse). Nucl. Instrum. Methods, 60: 157-63(Mar. 15, 1968). (In French).

A method to solve the problem of correction of resolution power effects in energy for scintillation counters is discussed. The pseudo-solution of the first kind of Fredholm equation, $\int_0^{E'_{max}} K(E,E')\rho(E')dE' = N(E)$, which allows the transformation of the spectrum N(E) affected by resolution power in a spectrum $\rho(E')$ corrected for these effects, is the solution of a second kind of Fredholm equation, $\int_{E_0}^{\infty}\int_0^{E'_{max}} K(E,E')K(E,\mu)\rho(\mu)dEd\mu + \lambda\rho(E') = \int_{E_0}^{\infty} K(E',E)N(E)dE$. Here λ depends on the experimental error on N(E). This method has been used in the particular case of deuterons scattered by 14 MeV and 2.7 MeV neutrons. (auth)

16865 WALL EFFECT IN BF_3 COUNTERS. Cervellati, R.; Kazimierski, A. (CNEN, Rome). Nucl. Instrum. Methods, 60: 173-8(Mar. 15, 1968).

Starting from earlier works in this field a theoretical account of the wall effect in BF_3 proportional counters is given. From the length distributions relative to α and lithium fragments and from approximate energy-range relations the pulse spectrum is calculated; asymmetry of the main peak, locations and amplitudes of the steps are explained. The best fit with an experimental spectrum (300 torr, 1" counter) is obtained assuming ranges for α and lithium fragments of 14 mm and 6 mm, respectively. (auth)

16866 EFFICIENT REPRESENTATION OF NaI(Tl) AND PROPORTIONAL COUNTER PULSE-HEIGHT SPECTRA. Purvis, A. E. (Texas Instruments, Inc., Dallas); Baggerly, L. L. Nucl. Instrum. Methods, 60: 179-81(Mar. 15, 1968).

A nonlinear energy interval representation of pulse-height spectra for NaI(Tl) and proportional counters has been developed which results in the peaks for all monoenergetic radiation being the same number of energy intervals wide. This representation preserves the general-shape characteristics of spectra while substantially reducing the number of intervals required to represent a spectrum. This technique is suggested as a spectral transformation to precede least-squares data reduction procedures. (auth)

16867 MEASUREMENT BY TWO-DIMENSIONAL PULSE ANALYSIS OF THE TIME AND ENERGY DISTRIBUTIONS OF AFTERPULSES IN PROPORTIONAL COUNTERS. Genz, H.; Harmer, D. S.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Nucl. Instrum. Methods, 60: 195-200(Mar. 15, 1968). (ORO-3346-14).

Measurements of afterpulses occurring in proportional counters were carried out by a method based on two-dimensional pulse analysis for time and energy distributions. An aluminum single-wire proportional counter of 2.06 cm radius, fitted with field tubes, was used with a filling of one atmosphere of 87% argon−13% propane gas. With radioactive ^{37}Ar contained in the counter gas, the energy distribution and time delays of the afterpulses initiated by K-capture events (2.82 keV, Auger electrons or K x-rays) were measured. With ultra-high purity argon counter gas (containing less than 10 ppM total impurities), the occurrence of afterpulses was of the order of 1 per 10^3 K-events. With normal purity argon, the rate of afterpulses per K-event was approximately doubled. The energy distribution of the afterpulses was studied in the region 0 to 100 eV for gas gains well within the region of proportionality and exhibited the form of a single-electron spectrum. The time delays were studied up to 64 msec. The time distribution of the afterpulses shows a maximum in the region of 120 to 160 μsec and a vanishing contribution for time delays longer than 400 μsec for our counter under the chosen experimental conditions. The maximum in the time distribution may be attributed primarily to a positive ion effect. The versatility of the method for a systematic and general study of afterpulses in various types of detectors is pointed out. (auth)

16868 LINEARITY AND RESOLUTION OF A ONE DIMENSIONAL POSITION SENSITIVE DETECTOR. Melzer, W.; Puehlhofer, F. (Max Planck Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods, 60: 201-4(Mar. 15, 1968).

Linearity and resolution of a one dimensional position sensitive Si surface-barrier detector were investigated. The experimental results agree within 20% with those predicted theoretically. The parameters of the detector were: active area 53 ×8 mm^2, junction capacitance 150 pF, resistance of the back layer 7.2 kΩ. The pulse shaping network consisted of a 0.7 μsec RC integration and 0.7 μsec single delay line clipping filter. The electronic noise of the position information was measured to be 52 keV (0.5 mm at 5.5 MeV) fwhm Si. The electronic noise of the energy information was 31 keV. Using 5.5-MeV α-particles 59-keV (0.57 mm) and 35-keV resolution, respectively, were measured. The non-linearity of the characteristics was less than 1% indicating that the variation of the position dependent ballistic deficit was also less than 1%. (auth)

16869 RECOMBINATION LUMINESCENCE IN THE HELIUM GAS OF HIGH PRESSURE: SCINTILLATION INDUCED BY ALPHA PARTICLES. Takahashi, Tan (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Soc. Jap., 24: 561-8(Mar. 1968).

The alpha-particle-induced scintillation of high pressure helium gas has been studied experimentally in the pressure range of 10 to 70 atm with an electric field applied in the region of the alpha tracks. Simultaneously with observation of the scintillation light yield, the ion current extracted from the alpha tracks by the field was measured. The results indicate that recombination luminescence increases with pressure and accounts for about 25% of the scintillation light yield at 60 atm. The decay time of the scintillation pulse is less than 0.5 μsec, which is much shorter than the decay time found at lower pressure. To analyze the electric field and pressure dependences of the light yield, the Jaffé theory was applied to diffusion and recombination of ions and electrons produced along the alpha tracks. The result shows that the pressure dependence of the recombination luminescence can be interpreted in terms of dissociative recombination of vibrationally excited He_2^+ and the recombination leading to scintillation continues during the relaxation of the vibration. Three-body recombination does not seem to play a significant role in the scintillation mechanism. (auth)

16870 RESPONSE OF PLASTIC SCINTILLATOR TO ELECTRONS. Sugiyama, Suguru; Tomimasu, Takio. Denki Shikensho Iho (Japan), 31: 913-22(1967). (In Japanese).

For the purpose of rejecting the surface effect on the response of plastic scintillators to external electrons, the scintillation response to positron–electron pair has been accurately measured by the use of a three-crystal scintillation spectrometer. The light output of plastic scintillator due to positron–electron pairs is composed of accumulated light output of positrons and electrons having an energy distribution of 0 to $h\nu-2\ m_0c^2$. The energy distribution of positron–electron pair is calculated according to the formula of Bethe and Heitler as well as the correction factor to Born approximation given by Nishina et al. According to Birks' theory, it is assumed that there is no difference in positron–electron scintillation response of plastics in the high energy range and that the scintillation response is a linear function with the energy. The results show that the scintillation response to electrons is linear above 100 keV with the intercept of 4.5 ± 1 keV and slightly nonlinear below 100 keV. With the aid of Birks' theory, the value of quenching factor kB is obtained to be 6 mg cm^{-2} MeV^{-1}. The value is considerably smaller than the reported data on proton and alpha particle response. (auth)

16871 INVESTIGATION OF THE LATENT PHOTOGRAPHIC IMAGES IN NUCLEAR EMULSIONS. Kocherov, N. P.; Perfilov, N. A. Zh. Nauch. Prikl. Fotogr. Kinematogr., 12: 442-51 (Nov.-Dec. 1967). (In Russian).

The efficiency of the photolytic (radiolytic) reactions and the dispersion of the latent images, formed by charged particles with different specific losses and formed by the effects of the light exposure of different duration and intensity, was investigated. The efficiency was measured in a wide range of variation of the specific energy loss of the charged particles. With increase of the specific energy loss in the case of charged particles the efficiency decreases. Direct data were obtained on the dispersion of the latent images. A method for the variation of the dimension of the latent image centers was proposed. Experimental evaluations were made of the dimensions of latent image centers, and the results were compared with threshold potentials of the development. On the basis of the analysis of the experimental data obtained, conclusions were drawn on the essential role of recombination processes during the formation of latent images during exposure at high intensity. (tr-auth)

16872 DESIGN OF A TRANSISTORIZED COINCIDENCE UNIT FOR ABSOLUTE $\beta\gamma$-COUNTING. Ali, Ahmad (Pakistan Inst. of Nuclear Science and Tech., Rawalpindi). J. Natur. Sci. Math., 7: 24-9(Apr. 1967).

The design of a coincidence unit used in $\beta\gamma$-counting systems for determination of absolute disintegration rate without involving the efficiencies of detectors is described. The electronic circuit used, has a two channel coincidence input having resolving time of ±1.25 and ±2.5 μsec and an output dead time of 10 μsec. The unit designed is all transistorized. (auth)

16873 ON THE EMISSION OF EXO ELECTRONS IN A GEIGER COUNTER. Sastri, R. C.; Chatterjee, S. D. (Jadavpur Univ., India). Indian J. Phys., 41: 617-18(Aug. 1967).

During a study of the mechanism of Geiger–Mueller counter discharge with reversed potentials it was observed that the number of cosmic ray background increased substantially when the normal potential distribution was restored after operating the counter in the reversed direction for a few minutes. This observed increase in the number of pulses was attributed to a copius emission of exo-electrons from the cylinder. (B.G.D.)

16874 A NOTE ON 'HAMMER' TRACKS HAVING NO ASSOCIATED BETA-PARTICLE. Deka, G. C. (Cotton Coll., Gauhati, India). Indian J. Phys., 41: 615-16(Aug. 1967).

An investigation of hammer tracks in nuclear emulsions in which beta tracks are found to be missing is reported. The reasons for not observing the beta tracks are estimated. (B.G.D.)

16875 ELECTRONICS SYSTEM FOR A BALLOON BORNE EXPERIMENT IDENTIFYING NUCLEAR CHARGE OF PRIMARY COSMIC RAY. Tsukuda, Masahiro; Murakami, Hiroyuki; Nagata, Katsuaki; Doke, Tadayoshi; Nakagawa, Shigeo. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 3: 500-6(July 1967). (In Japanese).

Description of balloon-borne electronic instruments capable of identifying heavy primary cosmic-ray particle charges is given. Primary emphasis in the circuit design is placed on compactness and low power consumption, so that the circuits are suitable to be put aboard a satellite. The minimum of the output pulse heights from four solid-state dE/dx counters is converted into a five-bit binary code and telemetered to the ground. The charge-sensitive preamplifier uses a positive current feedback and has an open-loop gain of 2800. The minimum pulse selection circuit is of analog type, using a fast transistor and circuit and gives an accuracy of better than 2% for voltage pulses between 0.1 and 5 V. The Wilkinson-type 32-channel pulse-height analyzer consumes 500 mw and has a differential linearity within ±5% over the temperature range from –15 to +30°C. A novel method of selecting a pulse whose amplitude ranks as the i-th among n coincident pulses of different amplitudes is also described. (IAA)

16876 CALORIMETRIC METHOD FOR THE MEASUREMENT OF GRENZ RAYS. Rollo, Frank D.; Katchis, Louis J.; Dauer, Maxwell (Univ. of Miami, Florida). Phys. Med. Biol., 13: 79-89(Jan. 1968).

Grenz rays are very soft x rays in the 5 to 20 keV range. A total absorption calorimeter is described which can be used to measure the total beam power and energy flux per Roentgen of a grenz ray beam in fundamental units. The calorimeter utilizes twin absorbers of identical construction. Each absorber contains a high resistance heating element for electrical calibration and a thermistor for sensing differential temperature changes between the absorbers. Beam power measurements are made by determining the rate of thermistor resistance change which occurs when one of the absorbers is exposed to x rays. This value is then compared with rates of resistance change which occur when known amounts of electrical energy are passed through the absorbers. From the beam power measurement, the cross-sectional area and exposure rate of the beam, the energy flux per Roentgen can be calculated. The experimentally determined values of energy flux per Roentgen for the range 10 kvp to 15 kvp showed a mean variation of 3.42% from the theoretical values computed from the true absorption coefficients for air, and a mean variation of 2.23% when compared with theoretical values computed from the fundamental parameters of the system. (auth)

16877 RECENT APPLICATIONS OF SEMICONDUCTOR TECHNIQUES IN THE STUDY OF NUCLEAR RADIATIONS.

Gunnersen, E. M. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Rep. Progr. Phys., 30: 27-95(1967).

The chief topic discussed is the application of semiconductor counters to the analysis of the properties of nuclear radiations, not only in nuclear physics, but also in space physics and medicine. The criteria governing the choice of suitable semiconductor materials for counters, the factors limiting resolution (e.g., the role of trapping in large lithium-drifted counters), the transmutation doping method of compensation, the ion implantation technique of making thin contacts, and irradiation damage effects in counters are discussed. Particular attention is given to the development and applications of lithium-drifted germanium, position-sensitive, and avalanche multiplication counters. Particle channelling and the potentialities of the ion implantation technique for making electronic devices are treated. Some recent applications of high purity semiconductor devices to the study of basic irradiation damage mechanisms in semiconductor materials are also described. (auth) (UK)

16878 SOLID-STATE RADIATION DETECTORS. **Dearnaley, G. (Atomic Energy Research Establishment, Harwell, Eng.). Contemp. Phys., 8: 607-26(Nov. 1967).**

A historical survey of the development of solid-state detectors is given, and it is shown why semiconductor detectors are superior to the earlier crystal counters. The physical processes which occur during the detection of nuclear radiation in a solid-state device are considered in detail, and the merits of the reverse-biased semiconductor junction in silicon or germanium are stated. Factors which determine the energy resolution of such a detector are analyzed, and also the effects of radiation damage. The preparation of such detectors is not treated in detail, but the physical principles on which the important types of detector depend are described. The applications of solid-state detectors in nuclear physics, radiochemical analysis, space research, medicine and biology are surveyed. (auth) (UK)

16879 CALCULATION OF LINEAR ENERGY TRANSFER OF VARIOUS RADIATIONS IN LIQUIDS WHICH MAY BE USED AS IONISATION CHAMBER FILLING. **Mathieu, Jacques; Patau, Jean-Paul; Blanc, Daniel (Faculte des Sciences, Toulouse). Health Phys., 14: 141-9(Feb. 1968). (In French).**

Principles of calculation methods for determining the mean linear energy transfer in some dielectric liquids are presented. The results permit calibration of the response of ionization chambers with fillings of these liquids. The cases of γ-rays whose energies lie below 2 MeV and fast neutrons of about 14 MeV are specially considered. (auth) (UK)

16880 DIRECT MEASUREMENT OF THE PRIMARY PHOTOELECTRON YIELD IN SODIUM IODIDE SCINTILLATION COUNTERS. **Houdayer, A.; Mark, S. K.; Bell, R. E. (McGill Univ., Montreal). Nucl. Instrum. Methods, 59: 319-21(Feb. 1968).**

The number, P, of photoelectrons produced per keV of electron energy absorbed in an NaI(Tl) scintillation counter has been measured directly with a charge-sensitive amplifier. The values obtained for selected detectors lie in the region of P = 10, in contradiction to a number of statements in the literature that P typically lies in the range from 1 to 3. (auth)

16881 LARGE SCINTILLATION DETECTOR FOR PHOTONEUTRON REACTIONS. **Cook, B. C.; Jones, C. C. (Ames Lab., Iowa). Nucl. Instrum. Methods, 59: 229-36(Feb. 1968). (IS-1679).**

A 40" liquid scintillation detector was constructed for use in photonuclear work. Integrated cross sections for reactions in which one or two neutrons are emitted were measured up to 50 MeV for fluorine. The efficiency of the detector was about 60%. (auth)

16882 THE LIQUID ARGON ACTIVATION DETECTOR (LAAD). **Flammang, N. K.; Reising, R. F. (McDonnell Douglas Corp., St. Louis). Nucl. Instrum. Methods, 59: 339-40(Feb. 1968).**

A liquid argon detector which also serves as a target was developed to study a new isomer, ^{40m}Cl. The detector's construction, use, characteristics, and potential uses are described. (auth)

16883 THE REGISTRATION OF CHARGED PARTICLES IN SOLIDS: AN ALTERNATIVE TO AUTORADIOGRAPHY IN THE LIFE SCIENCES. **Hamilton, E. I. (Radiological Protection Service, Sutton, Eng.). Int. J. Appl. Radiat. Isotop., 19: 159-61 (Feb. 1968).**

Most insulator solids, e.g., glass, natural silicates, apatite and plastics, record the passage of charged particles as narrow trails of radiation damaged material. The width of these linear damaged regions is ≈10 mμ and direct observation is only possible by means of electron microscopy. Chemical etching techniques have been described, however, whereby the damaged trails are preferentially dissolved to produce tubes about 1 μ in diameter. When viewed in transmitted light the tubes appear black. As the etching solution penetrates the matrix the hole is enlarged to produce a well defined track, which narrows with depth. The terminal portions of the tracks have a characteristic cone shape, which is easily distinguished from most linear imperfections that may exist in the sample. Under conditions of optimum etching the track holes can be enlarged and easily viewed with a conventional optical microscope. This method can therefore be used to detect the passage of charged particles, such as fission fragments or alpha particles, emitted from a sample in various solid detectors. The method has been used by the author to determine the distribution of uranium and plutonium in thin sections of animal tissue, plants, and natural waters. Polycarbonate plastic was used as detector and the tracks were etched in NaOH. Irradiations were carried out in the BEPO reactor at Harwell. (auth)

16884 TECHNIQUE FOR OBSERVING SMALL ANGLE INELASTIC PROTON SCATTERING. **Garvey, G. T.; Haight, R.; Lynch, R. P. (Princeton Univ., N. J.). Nucl. Instrum. Methods, 59: 357-9(Feb. 1968). (PUC-937-275).**

A setup in which the angle defining slit of a semi-conductor detector system is placed between the ΔE and E counters is shown to reduce the slit scattering background by a factor of 100. (auth)

16885 MINIMUM TIME RESOLUTION IN SCINTILLATION COUNTERS. **El-Wahab, M. A.; Sakka, M.; El-Salam, M. A. (Alexandria Univ., Egypt). Nucl. Instrum. Methods, 59: 344-6 (Feb. 1968).**

For a scintillator detector characterized by an equivalent illumination and having as SER a $\delta(t)$ pulse, a simple relation is derived connecting minimum resolving times with the optimum values n/N, where N is the total number of photoelectrons generated by one event in the scintillator and n the fraction used in processing the photomultiplier output. (auth)

16886 A CS_2 LYMAN-ALPHA PHOTON COUNTER. **Dose, V. (Univ., Zurich). Nucl. Instrum. Methods, 59: 322-4(Feb. 1968).**

A high counting rate Lyman-alpha photon proportional counter with a sensitivity of 20–25% is described which uses a photoelectron suppressor grid. The filling gas is CS_2. (auth)

16887 APPLICATION OF PLASTIC TRACK DETECTORS FOR DETECTION OF LIGHT NUCLEI. **Somogyi, G.; Varnagy, M.; Peto, G. (Inst. for Experimental Physics, Debrecen, Hungary). Nucl. Instrum. Methods, 59: 299-304(Feb. 1968).**

The possibilities of registrating and discriminating the products of the reactions D + D and D + T in cellulose nitrate and in cellulose acetate track detectors were studied. It has been shown, that the sensitivity of the solid state track detectors can be varied by using different etching reagents, and so it is possible to detect even proton tracks in these plastics. Using a given mixture as developing reagent, at cellulose acetate we evaluated the critical rate of energy loss for alphas, tritons and protons. The investigated plastics are applicable for studying such nuclear reactions where the outgoing particles are ^{3}H, ^{3}He, and ^{4}He. By means of this method we could monitor neutrons from D + D and D + T reactions, and determine the tritium contamination of a deuterium target. (auth)

16888 THE LIGHT OUTPUT OF NE 213 SCINTILLATORS FOR PROTONS. **Maier, K. H.; Nitschke, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Instrum. Methods, 59: 227-8(Feb. 1968). (In German).**

The light output of a NE 213 scintillator for protons was measured. The energy dependence is best described as proportional to $E^{3/4}$ for energies less than 5.25 MeV, and linear above. (auth)

16889 ABSOLUTE STANDARDIZATION WITH LIQUID SCINTILLATION COUNTERS. **Gibson, J. A. B.; Gale, H. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., E, 1: 99-106(Feb. 1968).**

The observed output from a liquid scintillation counter is compared with that predicted theoretically for a wide range of beta-ray emitters. It is demonstrated that the extrapolated integral bias curve has an intercept which is always less than the absolute activity, but this intercept can be calculated for any isotope, including tritium. The probability that no output will be observed from any event (zero probability) can be determined as a function of the combined efficiencies of the scintillator and photomultiplier (figure of merit). Methods of measuring the figure of merit are presented for both single photomultiplier tube and coincidence counters. Corrections for high specific energy loss (dE/dx), and losses at the boundaries of the scintillator are calculated and the corrected figure of merit is found to be independent of electron energy from 5 keV to 1 MeV. Absolute activities were determined for three isotopes, tritium, carbon-14, and chlorine-36. The results were in good agreement with the standards of Radiochemical Centre, Amersham, (UK), and the National Bureau of Standards, USA. The zero probabilities are largest for tritium, for example, 35% and 58% for single and coincidence counters, respectively. The tritium integral bias curve is shown to be essentially exponential over a wide range of bias voltage, and a logarithmic extrapolation to zero bias corresponds to the absolute activity with an accuracy to ±10%. (auth)

16890 IMPROVEMENTS IN OR RELATING TO NUCLEAR RADIATION FLUX MEASURING APPARATUS. Fowler, Eliot Patrick; Harrison, Donald; Levell, Roy William (to United Kingdom Atomic Energy Authority). British Patent 1,102,582. Feb. 7, 1968. Filed July 22, 1964.

A boron-coated ionization chamber connected with a logarithmic amplifier and a linear rectifier are described for the detection of neutrons. The system is designed to produce a dc output proportional to the logarithm of the input pulse due to the incident radiation. (W.H.K.)

16891 ELECTRICAL CALIBRATION MEANS FOR RADIAC EQUIPMENT. Falk, Fred W.; McCue, James M. U. S. Patent 3,359,420. Nov. 24, 1964.

The system is composed of a radiometer having a voltage supply, a detector circuit connected to said voltage supply through a potentiometer responsive to radiation from radiation sources for producing a voltage which is a function of the intensity of said radiation source, an amplifier having an input and an output with the input connected to said detector circuit and connected to said voltage source responsive to said detector circuit voltage for providing an amplified voltage at its output, a meter connected to the output of said amplifier responsive to the amplified voltage producing a current through said meter to indicate the intensity of the radiation impinging on said detector circuit and adjustable resistor shunting said meter for regulating the current in said meter. A means is incorporated in said radiometer for testing the voltage of said voltage supply and for adjusting the voltage on said detector circuit to compensate for low voltage of said voltage supply. Also a means is incorporated in said radiometer for testing the gain of said amplifier and the response of said meter and for permitting the adjustment of said adjustable resistor to control the current through said meter to compensate for low gain of said amplifier and low response of said meter, whereby said radiometer may be made to correctly indicate the radiation intensity when used to measure radiation intensity. (auth)

16892 DEVICE FOR MEASURING CONTINUOUSLY WITH A HIGH SENSITIVITY THE RADIOACTIVITY OF A LIQUID. Kage, Hakaru (to Hitachi Ltd.). Japanese Patent 1967-3757. Feb. 16, 1967. Filed May 18, 1960.

By the method proposed, the counting efficiency can be considerably increased, so that the radiation can be measured continuously of a low-radioactivity-level liquid such as treated waste. It consists of the chamber with a liquid entrance and exit; a large number of solid scintillators, distributed appropriately within the chamber; the painting on the inner surface of the chamber, which reflects the light from the scintillators; and a photomultiplier tube, located at such a position as to receive efficiently the light from the scintillators. (NSA of Japan)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 16929 and 18212.

16893 (CEA-R-3251) DETECTEURS A JONCTION AU GERMANIUM: ELEMENTS THEORIQUES ET PRATIQUES POUR L'UTILISATION EN SPECTROMETRIE DE RAYONNEMENTS. (Germanium Junction Detectors: Theoretical and Practical Factors Governing Their Use in Radiation Spectrometry). Hors, Michel; Philis, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 96p. (In French). Dep.

Semiconductor detectors have recently greatly increased the possibilities available to nuclear spectroscopists for the study of α, β and γ radiations. Their use in radiochemistry has encouraged us to study their principle, their mechanism and also the conditions under which they can be used. A summary of what should be known theoretically concerning the best use of junction detectors, in particular Ge(Li) detectors. A summary of experimental laboratory work carried out over a period of one year on Ge(Li) detectors. Stress is laid on the possibilities presented by the use of these detectors as photoelectric spectrometers, and also on the precautions required. Among the numerous results presented, the resolution of 2.52 keV obtained for the γ radiation of 145.5 keV for ^{141}Ce may be particularly noted. (auth)

16894 (CEA-R-3315) CONTRIBUTION A LA SPECTROMETRIE DES EMETTEURS β A L'AIDE DE DETECTEURS A JONCTION: ETUDE DES SPECTRES DU ^{35}S, ^{45}Ca, ^{204}Tl, ^{36}Cl. (Contribution to β-Emitter Spectrometry Using Junction Detectors: Study of ^{35}S, ^{45}Ca, ^{204}Tl, and ^{36}Cl Spectra). Hareux, Fernand (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 91p. (In French). Dep.

The possibilities of using beta spectrometers equipped with semiconductor detectors were explored. The optimum operating conditions and beta detection efficiencies of two types of junctions, surface-barrier and lithium-compensated, were examined. The resolving power was determined as a function of the polarization voltage. The time constants of the circuit and of the temperature were also determined. The beta spectra of ^{35}S, ^{45}Ca, ^{204}Tl, and ^{36}Cl under the best possible operational conditions were measured. An attempt was made to find a linear curie representation, as extended as possible, for each of these spectra. The maximum energy of the radioisotopes deduced from the curie representation was found to be: ^{35}S, 166 ± 1 keV; ^{45}Ca, 259 ± 2 keV; ^{204}Tl, 760 ± 4 keV; and ^{36}Cl, 708 ± 4 keV. (B.G.D.)

16895 SAMPLING BIAS IN SCANNING PROTON-RECOIL TRACKS IN NUCLEAR EMULSION. Lehman, R. L.; Fekula, O. M.; Wayland, J. R. Jr. (Univ. of California, Los Angeles). Nucl. Instrum. Methods, 60: 205-12(Mar. 15, 1968). (UCLA-12-662).

A new rapid random-drift method of sampling track distributions in nuclear emulsion was tested for bias. After detailed consideration of geometrical correction factors and the types and sources of tracks in the samples, length and angular distributions from emulsions exposed to single-energy neutron beams were compared with those predicted by s-wave scattering. This study revealed no sampling bias, and demonstrated that a differentiation method can provide improved resolution in emulsion neutron spectroscopy. (auth)

16896 MODEL UMB MAGNETIC BETA SPECTROMETERS. Gumenyuk, B. A.; Granberg, G. L.; Ivanova, G. D.; Peregood, B. P.; Cherstvov, L. A. (Ioffe Physical Technical Inst., Leningrad. Fizpribor Works, Moscow). Nucl. Instrum. Methods, 60: 164-72(Mar. 15, 1968).

It is shown that the possibilities offered by magnetic beta spectrometers whose electron optical diagram is similar to the diagram of optical spectrometers can be considerably broadened by using variable field distribution lenses for collimation and focusing. A Model UMB-1M spectrometer is described whose resolving power attains 0.014% at a solid angle $\Omega = 0.02\%$ from 4π and a source measuring 12×0.4 mm^2. The maximum solid angle is 2% from 4π, the resolving power under these conditions being 0.6% at a source and entrance slit measuring 15×1 mm^2. An experiment is described aimed at increasing the spectrometer luminosity by means of electrical matching of electron optical images of several sources. Calculated characteristics of Model UMB-2 spectrometer are given. (auth)

16897 NUCLEAR SPECTROMETRIC SYSTEM USING A PDP 8 COMPUTER IN REAL TIME. Verroust, G. (Faculte des Sciences, Orsay, France). Bull. Inform. Sci. Tech. (Paris), No. 120, 61-70(Nov. 1967). (In French).

In order to incorporate the inherent advantages of on-line computing into a nuclear spectrometric system, a CA 25 amplitude coder was linked to a PDP-8 computer by a specially designed interface. The author et al., have also produced a control console which fully automatizes the operation of the system by the use of a special program. A brief background survey is followed by a description of the system and an indication of its performances. (auth)

16898 MEASUREMENT OF ANISOTROPIC FAST-NEUTRON SPECTRA WITH NUCLEAR EMULSION TECHNIQUES. Roberts, J. H.; Behkami, A. N. (Northwestern Univ., Evanston, Ill.). Nucl. Appl., 4: 182-6(Mar. 1968).

Improvements in a technique for deducing the spectrum of fast neutrons from the measurement of proton recoil tracks in nuclear emulsions are described. The source of neutrons may be anisotropic. Tests were made by placing Ilford L4 emulsion plates in an assembly of depleted uranium (0.21% ^{235}U) in which neutrons are produced by photofission. The photofission was induced by bremsstrahlung produced when a pulsed 30-MeV electron beam from a LINAC hit a target of depleted uranium within the assembly. Special development with Amidol developer was used to reduce chemical fog and gamma-ray background in the emulsions, permitting a measurement of proton tracks down to about two microns. The neutron spectrum from ≈0.3 to 2.5 MeV is deduced from the measurements. Computer programs were developed to make the calculations. Results up to ≈0.9 MeV are compared with the neutron spectrum measured by time-of-flight techniques. Satisfactory agreement is obtained. (auth)

16899 A PRECISION VELOCITY GENERATOR SUITABLE FOR MOESSBAUER EXPERIMENTS. **Clark, P. E.; Nichol, A. W.; Carlow, J. S. (Univ. of Exeter, Eng.). J. Sci. Instrum., 44: 1001-4(Dec. 1967).**

The voltage waveform required to drive a moving-coil transducer is the sum of a set of functions which are the integral and differentials of the desired velocity response. An approximation to such a waveform may readily be synthesized, so that negative feedback in the control of a vibrating system may be reduced to the provision of second-order corrections. In a practical system developed to provide a motion at constant acceleration for Moessbauer experiments a relative error of 0.1% over most of the duty cycle has been achieved, with an improvement in stability over previous arrangements. (auth) (UK)

16900 DESIGN, CONSTRUCTION AND PERFORMANCE OF 60° DOUBLE FOCUSING MAGNETIC SPECTROMETER. **Bhattacharya, P. K.; Bhiday, M. R. (Shri Govindram Seksaria Technological Inst., Indore, India). Indian J. Pure Appl. Phys., 5: 386-90(Sept. 1967).**

Design, construction and performance of a 60° double-focusing magnetic analyzer for use in the measurement of the Bhabha exchange parameter are described. The field profile was made slightly adjustable so as to give the best fit with the theoretical shape. The second-order fringing perturbation inside the field gap was eliminated by using shims of special design. A semicircum-trapezoidal core was found best for the redistribution of the core loss. The performance of the magnet was checked using the beta lines of ^{137}Cs and $^{152-154}$Eu. The solid angle of acceptance is 0.004 steradian. (auth)

16901 MULTI-ELEMENT DETECTORS FOR ACTIVATION RESONANCE INTEGRAL AND RESONANCE SPECTRUM MEASUREMENTS. **de Lange, P. W.; Bigham, C. B. (Atomic Energy of Canada Ltd., Chalk River). Nucl. Appl., 4: 190-5(Mar. 1968).**

A lithium-drift germanium γ-ray spectrometer can resolve and measure separately the activities of six elements mixed together in multi-element detectors. The activators and main resonance energies were ^{115}In (1.4 eV), ^{197}Au (4.9 eV), ^{75}As (47 eV), ^{198}Pt (96 eV), ^{98}Mo (467 eV), and ^{68}Zn (514 eV). The detectors were made by loading the six elements into epoxy resin. The results showed that good uniformity had been obtained and gave reduced resonance integrals for ^{68}Zn 0.40 ± 0.06b (for ^{69m}Zn formation), ^{75}As (58.8 ± 3.4b), ^{98}Mo (6.3 ± 0.8b), and ^{198}Pt (50 ± 6b). (auth)

16902 IMAGE ABERRATIONS OF SECOND ORDER OF ELECTROSTATIC SECTOR FIELDS. **Wollnik, H. (Justus-Liebig-Univ., Giessen, Ger.). Nucl. Instrum. Methods, 59: 277-82(Feb. 1968).**

The ion optical properties of electrostatic sector fields are described here in a second order approximation for three dimensional particle trajectories. All influences of the fringing fields are taken into account in the same approximation. The resultant aberrations differ considerably from older expressions as far as they have been calculated. This work is the counterpart to an article on image aberrations of a magnetic sector field, in which also a possibility is shown how such aberrations can be corrected. (auth)

High Energy Physics Instrumentation

16903 (RHEL/R-150) MODIFICATIONS TO THE RHEL GEOMETRICAL RECONSTRUCTION PROGRAM. **Burren, J. W.; Sedman, E. C. (Rutherford High Energy Lab., Chilton (England)). Sept. 1967. 38p. Dep. CFSTI. UK 5s. 6d.**

Improvements made to the R.H.E.L. geometrical reconstruction program for bubble chamber tracks are described. (auth)

16904 RESPONSE OF AN ANTHRACENE SCINTILLATION COUNTER TO LOW-ENERGY ELECTRONS. **Schmidt, V.; Wallek, L. (Univ., Muenster, Ger.). Z. Phys., 210: 164-78 (Feb. 12, 1968). (In German).**

A study was made to determine the influence which an anthracene scintillation counter exerts on the detection of low energy external electrons. Since in such an investigation several processes are involved, the photomultiplier's single electron line, the line shape of photomultiplier anode pulses for excitation of the scintillator by external electrons with energies from 1 to 29 keV, the mean pulse height–energy relation and the relative variance–reciprocal energy relation for these line shapes were studied. A short way to calculate a detection probability as a function of energy absorbed in the crystal is shown. (auth)

16905 FAST ELECTRONS AND X RADIATION DURING THE INITIAL STAGES OF AN IMPULSE SPARK DISCHARGE IN AIR. **Stankevich, Yu. L.; Kalinin, V. G. Dokl. Akad. Nauk SSSR, 177: 72-3(Nov.-Dec. 1967). (In Russian).**

Clarification of the mechanism involved in spark discharge in gases at high pressures requires knowledge of the electron energy in the avalanches during the initial stages of the discharge. Although the kinetic electron energy near the disruptive discharge voltages amount only to a few eV, the electron acquires much higher energies in the avalanches. The time-of-life of fast electrons is limited by the period of growth of the streamers which move at a rate of 10^8 to 10^9 cm/sec. Experiments were carried out to prove the existence of fast electrons under such conditions, using a discharge through a 0.4 mm gap between the electrodes. This was achieved by applying a voltage pulse for 23 nsec, with a growth period of about 2 nsec. An organic scintillator was used to detect the bremsstrahlung. The radiation intensity was measured by comparing it with a 5.9 keV γ quantum source of ^{55}Fe. The results indicated that during the initial stages of the spark discharge the electrons acquire energies of the same order as the applied voltage. This energy, which is due to the continuous acceleration in the avalanches, affects the further development of the spark channel. (TTT)

16906 USE OF A C.D.C. 160 A COMPUTER FOR THE ANALYSIS OF PATH CHAMBER PHOTOGRAPHS. **Fiehrer, M.; Goldwasser, M. (CEA, Cadarache, France). Bull. Inform. Sci. Tech. (Paris), No. 120, 57-60(Nov. 1967). (In French).**

High energy physical experiments madc with bubble or spark chambers involve the analysis of large numbers of photographs. The Elementary Particle Physics Division of the C.E.A. has installed two automatic systems to perform this function: ARIANE for spark chamber photographs, and HPD for those taken in bubble chambers. Both systems are equipped with CDC 160 A computers, for the purpose of: operational control and limited processing of data and recording on magnetic tape. (auth)

16907 PARTICLE PHOTOGRAPHY AT THE STANFORD LINEAR ACCELERATOR CENTER. **Burack, Michael L. Photogr. Appl. Sci. Technol., 2: No. 5, 19-23; 40-1; 44(Winter 1967-68).**

An outline of the photographic equipment and techniques employed for high-energy particle track detection at the Stanford linear accelerator is presented. Bubble chamber photography and streamer chamber photography are discussed. (W.H.K.)

16908 FAST DECISION-MAKING SPARK CHAMBERS. **Kissler, K. H.; Kose, R.; Trinks, U. (Univ., Bonn. Kernforschungsanlage, Juelich, Ger.). Nucl. Instrum. Methods, 59: 293-8(Feb. 1968).**

A decision-making system of current spark chambers was developed to preselect scattering events. The current signal amplitude of a single chamber appears about 100 nsec after the ignition of the switching spark gap and is a linear function of the coordinate x of the spark position and independent of the coordinate y, orthogonal to x. It is not possible to measure both coordinates simultaneously by one gap. The uncertainty is smaller than ±1% of the useful x-range. Multiple spark events cannot be resolved. (auth)

16909 REFRACTIVE INDICES OF LIQUID PROPANE AT BUBBLE-CHAMBER TEMPERATURES. **Gamalii, A. F.; Gorbunkov, V. M.; Solovev, M. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 342(Oct. 1967).**

Translated from Opt. Spektrosk., 23: 633-4(Oct. 1967).

The refractive indices of liquid propane were measured for three wavelengths of the mercury spectrum in the temperature range from 17.4 to 65.8°C and the pressure range from 7.6 to 23.4 atm. (W.H.K.)

Radiation Dosimeters

Refer also to abstract 18590.

16910 (HASL-189) PRELIMINARY EVALUATION OF CaF_2 THERMOLUMINESCENT SYSTEMS FOR USE IN LOW DOSE PROBLEM AREAS. **Shambon, A. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Nov. 1967. 38p. Dep. CFSTI.**

Two CaF_2 systems, natural CaF_2, and CaF_2:Mn were investigated for linearity of response, energy dependence, readouts of nonexposed dosimeters, reproducibility, and accuracy to determine their suitability for use in the two low dose problem areas of population exposure to environmental radiation and personnel monitoring. It was found that measurement of radiation between 2 and 5 mR is feasible with careful dosimeter calibration. (auth)

16911 POSSIBILITIES OF USING SYNTHETIC POLYMERS IN NUCLEAR EMULSIONS FOR THE DOSIMETRY OF FAST NEUTRONS. **Bradna, F. (Nuclear Research Inst., Rez, Czechoslovakia). Czech. J. Phys., 18: 251-65(1968).**

The results obtained in the process of the preparation and study of the properties of nuclear emulsion of a new type made especially for fast neutron dosimetry are presented. Synthetic hydrophilic polymers were used for the preparation of the emulsion and the sensitivity to fast neutrons, by the detection of recoil protons, was increased by enriching the emulsion with elementary hydrogen and by use of additive recoil proton radiators. The dosimetric results obtained with this emulsion are compared with the results achieved by various authors with the gelatine emulsions used up to now. (auth)

16912 FADING CHARACTERISTICS OF THERMOLUMINESCENT LITHIUM FLUORIDE. Suntharalingam, N. (Univ. of Wisconsin, Madison); Cameron, J. R.; Shuttleworth, E.; West, M.; Fowler, J. F. Phys. Med. Biol., 13: 97-104(Jan. 1968).

In view of conflicting results on the fading characteristics of lithium fluoride, a careful reinvestigation was made on possible fading of the commonly used phosphor, lithium fluoride TLD-100. Measurements over a twelve week period on freshly irradiated powder from a new batch, and also on some old powder, indicated fading of 5 ± 3%, most of which might have been due to changes in sensitivity after annealing. Recommendations are made for the proper use of the phosphor in radiation dosimetry applications. (auth)

16913 SCINTILLATION DOSE-RATE METER FOR THE MEASUREMENT OF X AND GAMMA RADIATIONS. Arsaev, M. I.; Osopov, B. E.; Sulimova, N. E. (Inst. for Radiation Hygiene, Leningrad). Health Phys., 14: 273-4(Mar. 1968).

The dosimeter described was constructed to measure dose rates in the ranges 30 to 3,000 keV and 0.1 to 300 μR/sec. A polystyrene scintillator is employed, containing ZnS(Ag). The electronics are briefly described. The equipment is isotropic for angles 0 to 180°. It can operate in a constant magnetic field. (UK)

16914 NEW DEVELOPMENTS IN THERMOLUMINESCENT DOSIMETRY. Schayes, R.; Brooke, G.; Kozlowitz, I.; Lheureux, M. (Manufacture Belge de Lampes et de Materiel Electronique, Brussels). Health Phys., 14: 251-63(Mar. 1968).

After a survey of usable phosphors and their efficiency, an operational system of thermoluminescent dosimetry is presented. The effect of peak height vs. integral measurement of the glow curve is investigated. The main characteristics of the various thermoluminescent dosimeter types are summarized, and the range and limits of use studied. All known methods for multiple readings of thermoluminescent dosimeters are described. (auth)

16915 ENERGY DEPENDENCE OF LiF AND CaF_2 THERMOLUMINESCENT DOSIMETERS FOR HIGH ENERGY ELECTRONS. Nakajima, T.; Hitaoka, T.; Habu, T. (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys., 14: 266-7(Mar. 1967).

A study is described of the energy dependence of LiF and CaF_2 thermoluminescent dosimeters, placed in water, for the broad beams of electrons from 10 to 30 MeV from a betatron, and for the γ-rays of ^{60}Co. The absorbed dose in water was estimated by a cavity ionization chamber. Conversion of the cavity ionization into rad in water was carried out by using the tabulated values of the stopping power ratio. (auth)

16916 METHOD FOR REM MEASUREMENTS IN FIELDS OF MIXED GAMMA-NEUTRON RADIATION. Keirim-Markus, I. B.; Markelov, V. V.; Chernykh, I. V. (Inst. of Biophysics, Moscow). Prib. Tekh. Eksp., No. 4, 65-7(July-Aug. 1967). (In Russian).

The dose equivalent E expressed in rems is equal to the tissue dose D expressed in rads multiplied by a quality factor η which depends on the linear energy loss of the primary or secondary charged particles: $E = \bar{\eta}D$. It is proposed that $\bar{\eta}$ be measured by using an organic, tissue-equivalent scintillator, whose relative, energy, luminescence yield ϵ falls with an increase in L (the linear energy loss). It is noted that $\bar{\eta}$ (L) = B[1 − C$\bar{\epsilon}$(L)]. The term $\bar{\epsilon}$ can be determined by comparing the scintillator photocurrent with the ionization current of the tissue-equivalent chamber which does not depend on L. This method of measurement can be used in mixed gamma-neutron fields. (TTT)

16917 PERSONAL FAST NEUTRON MONITORING BY USE OF KODAK NTA FILMS. Bekes, Martonne. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 16: 57-64(1968). (In Hungarian).

Investigations in connection with routine dose measurements for personal fast neutron monitoring are reported. The energy and angular dependence as well as the fading of the Kodak NTA track film applied in the measurement have been evaluated. The film permits to cover doses and energies from 0.05 to 10 rem and from 0.5 to 14 MeV, respectively, provided the gamma dose does not exceed 1 R. Experiences in fast neutron dose measurements, performed at the Institute routinely since 1964, are discussed. (auth)

16918 RADIATION DOSIMETRY ON THE GEMINI AND APOLLO MISSIONS. Warren, Carlos S.; Lill, Joseph C.; Richmond, Robert G.; Davis, William G. (Manned Spacecraft Center, Houston, Tex.). J. Spacecraft Rockets, 5: 207-10(Feb. 1968).

US astronauts are equipped with radiation-dose recording instrumentation. The dosimetry used on Gemini and that designed for use on Apollo are described. Radiation doses received by Gemini crews varied between less than 10 mrad on the Gemini VIII mission (Neil A. Armstrong and David R. Scott) and 779 on the Gemini X mission (Michael Collins). Particle spectrometers were flown on the Gemini IV and VII missions in order to compare dose calculations to measurements. Radiation instrumentation for Apollo consists of a particle spectrometer, rate-meters, integrating dosimeters, and passive dosimeters. The rationale for each instrument is discussed. Calculated doses in the Apollo vehicle are presented for intense events in the last solar cycle. (auth)

16919 THERMOLUMINESCENCE-THEORY AND APPLICATIONS. Fenger, J.; Mejdahl (Danish Atomic Energy Commission, Risoe). Forsk. Udvikling-Uddannelse (Copenhagen), 77: No. 1, 11-15(Jan. 15, 1968).

The history and theory of thermoluminescence are briefly described. The practical applications are reviewed with emphasis on dosimetry and age determination, both of which applications are being developed at the Danish AEC Research Establishment Risö. (auth) (Denmark)

16920 NEUTRON DOSIMETRY IN RADIOLOGICAL PROTECTION. Peirson, D. H. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Med. Biol., 13: 69-77(Jan. 1968).

Instruments are currently available for the measurement of dose equivalent rate over various ranges of neutron energy, the dose due to criticality accidents, and the dose equivalent to a person under chronic exposure. Shortcomings in the techniques are discussed, and possible developments are considered. Technical refinements are more likely than the discovery of new instrumental principles. Most important could be changes in the specification of permissible levels arising from an improved understanding of the biological effects of radiation. (auth)

Radiometric Instruments

Refer also to abstracts 16636, 16638, 16639, 16749, and 16778.

16921 DEEP-WATER ISOTOPIC CURRENT ANALYZER. Gerrard, Martha. Isotop. Radiat. Technol., 5: 208-12(Spring 1968).

Three radioisotope-based instruments for determining current speed and direction and the early tests on them are described. The first two are radioactive tracer (^{131}I) drift instruments for use down to 400-ft and 1-mile depths, respectively. The third is a tilt meter, which has been tested at 15 ft, in which the angle of tilt is measured by the attenuation of beta radiation (^{106}Ru). (auth)

16922 NEUTRON RADIOGRAPHY. Hendry, I. C. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Nucl. Eng., 106-8(Feb. 1968).

Three detector techniques are discussed including the transfer method where an activation foil records the image which is transferred to x-ray film; the direct method, where a scintillation detector is used in contact with photographic film; and an instantaneous method, where a scintillator is coupled to an image intensifier. The radiography facility at DMTR, which uses the transfer method, is described. (W.H.K.)

16923 IMPROVEMENTS IN THE METHOD OF MEASURING THE DENSITY OF SOIL USING NUCLEAR BACK-SCATTER. Taylor, D.; Kansara, M. (Univ. of Strathclyde, Eng.). Nucl. Instrum. Methods, 59: 305-8(Feb. 1968).

The effect of soil type on the accuracy of the counting rate/density characteristic of the gamma-ray back-scatter gauge can be very much reduced by limiting the scattering angle $<\frac{1}{2}\pi$. This may be achieved by using a scintillation counter in place of the Geiger counter and introducing circuit which cuts off at an energy (E_{min}) given by $E_{min} = E/[1 + \alpha(1 - \cos\phi_m)]$, α being $E/(m_e c^2)$ and ϕ_m the maximum scattering angle to be allowed. The method reduces the volume of ground investigated by a factor of about 20 times as compared with the standard instrument. However, the use of a scintillation counter and the same radioactive source, because of the higher detection efficiency obtained, compensates for this volume effect and allows the same counting rate and, therefore, the same precision of measurement to be obtained. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 17111, 17291, and 18103.

16924 (AECL-2796) SCALER FOR HEALTH PHYSICS. Jones, A. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Dec. 1967. 9p. Dep. CFSTI. CAN.

The report describes the design and performance of a scaler for use with health instruments. It is small, light and rugged and operates from line power or internal rechargeable batteries for at least eight hours. It has six digits displayed on a register and four on meters. Pulses of either polarity are counted with a dead time of about 0.5 μs. The register limits counting rates to 400,000 pps. The scaler can count pulses directly from a G-M counter or photomultiplier tube. An appendix gives operating instructions and lists some instruments which will drive the scaler. (auth)

16925 (BNWL-680, pp 5-6) MARK-II IN-CELL RECORDING OPTICAL SPECTROMETER. Upson, U. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Design modifications are described for the Mark II in-cell recording optical spectrometer used in operating the A-Cell ion exchange equipment at BNWL. (B.G.D.)

16926 (CEA-R-3331) ICTOMETRE NUMERIQUE A CONSTANTE DE TEMPS VARIABLE A CIRCUITS INTEGRES. (Numerical Ictometer With Variable Time Constants and Integrated Circuits). Kaiser, Josef; Fuan, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 23p. (In French). Dep.

This prototype is built entirely of MECL-type integrated circuits from Motorola and is thus contained in two relatively small boxes. (auth)

16927 (CEA-R-3344) CONDUCTIMETRE SANS ELECTRODE. (Electrode-Less Conductivity Meter). Degryse, Michel; Bourg, Francois (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 16p. (In French). Dep.

The apparatus described measures continuously, with an accuracy of better than 1 per cent, the conductivity of solutions containing large amounts of inorganic products. The design of this industrial apparatus results in the elimination not only of the drift which can affect the measurements, but also of difficulties normally found in conventional electrode conductivity meters. Characteristics: range, 500 and 1000 mhos; sensitivity threshold, 0.5 per cent of the maximum signal; and output range, 0-50 mV, 0-10 volts. (auth)

16928 (CEA-R-3394) LES MEMOIRES ASSOCIATIVES EN PHYSIQUE NUCLEAIRE. (Association Memories in Nuclear Physics). Blanca, Ernest; Carriere, Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 43p. (In French). Dep.

Experiments in nuclear physics involve the use of large size memories. After showing the difficulties arising from the use of such memories, the principles of the various programming methods which make it possible to operate the memories associatively thus benefitting from a reduction in size and better operational conditions are given. They attempt to estimate the shape and dimensions of an associative memory with cable connections which could be designed specially for nuclear research, contrary to those actually in service. (auth)

16929 (EIR-130) A GENERATOR FOR PRODUCING A PRECISE DELAY OF UP TO 9 ms IN A TIMING SIGNAL. Behringer, K.; Dubochet, E. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Jan. 1968. 18p. Dep.

A unit has been developed which precisely delays a timing signal in steps of 60 μs up to 8.6 ms. The temperature coefficient of the delay is of the order 10^{-5}/°C. Specifications are presented. (auth)

16930 (INP-565/PL) PRZELICZENIE KATA Z UKLADU LABORATORYJNEGO NA KAT W UKLADZIE CENTRUM MAS ORAZ PRZELICZENIE ODWROTNE. PROGRAMY DLA MASZNY CYFROWEJ UMC-1 PRZY PROGRAMIE PODSTAWOWYM K-1. (The Calculations on an Angle From the Lab-System for an Angle in the CM-System and the Contrary Calculations. The Programs for the Computer UMC-1 With the Fundamental Program K-1). Jelonek, Stanislawa (Institute of Nuclear Physics, Krakow (Poland)). 1967. 23p. (In Polish). Dep.

The first program counts over again an angle from the LAB-system for an angle in the CM-system. The second one does the same calculations and counts additionally $\sin^4 0.5\Theta_{CM}$. The third one counts over again an angle from the CM-system for angle in the LAB-system. (auth)

16931 (JINR-P9-3675) ANALIZ RABOTY TIRATRONNOGO TRIGGERA S NELINEINOI NESIMMETRICHNOI NAGRUZKOI. (Analysis of Operation of a Thyratron Trigger With Nonlinear Asymmetrical Loading). Enchevich, I. B.; Tomilina, T. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 44p. (In Russian). Dep.

The schemes of thyratron triggers with nonlinear asymmetrical loading are analyzed. The criteria of a stable operation of such triggers are given and a method for calculation of a loaded trigger scheme is suggested taking into account the effect of the reverse conductance of thyratrons. (auth)

16932 (ORNL-TM-1638(Pt.16)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 16. VERNISTAT ADJUSTABLE FUNCTION GENERATOR, ORNL MODEL Q-2616. Fray, E. N. (Oak Ridge National Lab., Tenn.). Jan. 9, 1968. Contract W-7405-eng-26. 9p. Dep. CFSTI.

The circuit, application, and maintenance instructions for a Vernistat Adjustable Function Generator are described. The Vernistat is a commercial instrument adapted for use with Wide-Range Counting Channels of the ORNL Modular Reactor Instrumentation series Q-2600. (auth)

16933 (ORNL-TM-1638(Pt.19)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 19. +15 VOLT AND +25 VOLT VOLTAGE REGULATORS, ORNL MODEL Q-2619. Lingar, W. E. (Oak Ridge National Lab., Tenn.). Jan. 22, 1968. Contract W-7405-eng-26. 15p. Dep. CFSTI.

The +15 Volt and +25 Volt Voltage Regulator module is for use in providing regulated voltages for nuclear reactor instrumentation. The input is a dc voltage in the range of +28 to +36 V. The regulators are packaged in a standard plug-in module of the ORNL Modular Reactor Instrumentation Series. The circuits, applications, maintenance procedures, and acceptance tests for the regulators are described. (auth)

16934 (ORNL-TM-1638(Pt.20)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 20. -15 VOLT AND -25 VOLT VOLTAGE REGULATORS, ORNL MODEL Q-2620. Lingar, W. E. (Oak Ridge National Lab., Tenn.). Jan. 22, 1968. Contract W-7405-eng-26. 15p. Dep. CFSTI.

The -15 Volt and -25 Volt Voltage Regulator module is for use in providing regulated voltages for nuclear reactor instrumentation. The input is a dc voltage in the range of -28 to -36 V. The regulators are packaged in a standard plug-in module of the ORNL Modular Reactor Instrumentation Series. The circuits, applications, maintenance procedures, and acceptance test for the regulators are described. (auth)

16935 (ORNL-TM-1638(Pt.21)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 21. +10 VOLT AND -10 VOLT VOLTAGE REGULATORS, ORNL MODEL Q-2621. Lingar, W. E. (Oak Ridge National Lab., Tenn.). Jan. 22, 1968. Contract W-7405-eng-26. 15p. Dep. CFSTI.

The +10 Volt and -10 Volt Voltage Regulator module is for use in providing regulated voltages for nuclear reactor instrumentation. The input to the +10 V regulator circuit is a dc voltage in the range of +28 to +36 V. The input to the -10 V regulator circuit is in the range of -28 to -36 V. The regulators are packaged in a standard plug-in module of the ORNL Modular Reactor Instrumentation Series. The circuits, applications, maintenance procedures, and acceptance test for the regulators are described. (auth)

16936 (ORNL-TM-1638(Pt.23)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 23. RELAY SAFETY ELEMENT, ORNL MODEL Q-2623. Fray, E. N. (Oak Ridge National Lab., Tenn.). Jan. 8, 1968. Contract W-7405-eng-26. 9p. Dep. CFSTI.

The circuit, application, maintenance procedures, and acceptance tests for a Relay Safety Element are described. The circuit, which forms part of a relay coincidence network, is constructed in a 2-unit module of the ORNL Modular Reactor Instrumentation series Q-2600, and is intended for use in safety systems of reactors employing this series of instruments. (auth)

16937 (ORNL-TM-1638(Pt.24)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 24. COINCIDENCE MATRIX MONITOR, ORNL MODEL Q-2624. Fray, E. N. (Oak Ridge National Lab., Tenn.). Jan. 9, 1968. Contract W-7405-eng-26. 9p. Dep. CFSTI.

The circuit, applications, and maintenance instructions for a relay Coincidence Matrix Monitor are described. The circuit is constructed in a 4-unit module of the ORNL Modular Reactor Instrumentation series Q-2600, and is intended for use in safety systems of reactors employing this series of instruments. (auth)

16938 (RISO-165) ANALYSIS OF FAILURE DATA FOR ELECTRONIC EQUIPMENT AT RISO FOR THE PERIOD 1960-1965. Timmermann, P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct. 1967. 14p. Dep.

An analysis is made of failures in electronic equipment for the five-year period 1960–1965. The data are presented from the point of view of reliability prediction and not as a feedback for a more reliable design. (auth) (Denmark)

16939 (WCAP-3690-3) DEVELOPMENT OF A BORON CONCENTRATION METER. Technical Progress Report for the Period Ending December 31, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Jan. 1968. Contract AT(30-1)-3690. 28p. (EURAEC-1827). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The design and evaluation of two prototype boron-concentration meters are presented. One meter is based on conductivity measurements of a boric acid solution with mannitol added. The second meter is based on the neutron absorption principle, and a boron trifluoride detector is used. (W.H.K.)

16940 INVESTIGATION ON THE DOUBLE REFLECTION NEUTRON CRYSTAL MONOCHROMATOR. Choi, C. S. (Picatinny Arsenal, Dover, N. J.). Nucl. Instrum. Methods, 60: 182–8 (Mar. 15, 1968).

A small neutron monochromator was built to operate inside the reactor beam port. The device provides for consecutive reflection from two identical crystals, and so gives a beam in the same direction and position independently of the neutron wavelength. Factors affecting the instrumental resolution are discussed. The intensity is necessarily much less than in the single reflection method, but the unwanted second order neutron contaminations are reduced to less than 10% of what they would be with single reflection. Large fluctuations due to simultaneous Bragg reflection were observed in the primary beam intensity. The effect is much more noticeable with this device than with a single reflection crystal monochromator, and the orientations of the various contributing planes are discussed. (auth)

16941 FIELD OF A THREE-ELECTRODE ELECTROSTATIC CYLINDRICAL LENS. Glikman, L. G.; Yakushev, E. M. Zh. Tekh. Fiz., 37: 2097–9(Nov. 1967). (In Russian).

The electrostatic field of a system of three electrodes, held at arbitrary potentials, of which the first consists of the two half-planes $y = \pm H_1$, $z < -L$, the second, of the two full planes $y = \pm H_2$, and the third, of the two half-planes $y = \pm H_3$, $z > L$, where x, y, and z are rectangular Cartesian coordinates was calculated. A system of this type could find use as a cylindrical lens in an electrostatic beta spectrometer, either as an independent deflecting element or as part of an electrostatic prism. The problem is solved with the aid of a Schwarz–Christoffel transformation and the solution is given in parametric form. (ATD)

16942 ELIMINATION OF PULSE PILEUP DISTORTION IN NUCLEAR RADIATION SPECTRA. Blatt, S. L. (Ohio State Univ., Columbus. Stanford Univ., Calif.); Mahieux, J.; Kohler, D. Nucl. Instrum. Methods, 60: 221–30(Mar. 15, 1968).

During the recording of pulse-amplitude spectra from nuclear radiations, distortions are produced when two or more pulses occur within the resolving time of the linear amplifier in use. Several fast-logic systems have been developed to remove these distortions by rejecting piled-up pulses. One system, built primarily from commercial logic units, operates satisfactorily with a NaI(Tl) spectrometer at total counting rates up to 7×10^5 pps. Further improvements are proposed. Additional systems are proposed for amplitude correction, rather than rejection, of the piled-up pulses. These latter systems should allow the use of substantially increased total counting rates, taking full advantage of the improved counting statistics, while maintaining satisfactorily low spectrum distortions. (auth)

16943 SINGLE-CHANNEL AMPLITUDE RAPID PILE-UP SELECTOR. Bernard, P.; Chambon, J.; Mey, J.; Van Zurk, R. (Centre d'Etudes Nucleaires, Grenoble, France). Nucl. Instrum. Methods, 60: 213–18(Mar. 15, 1968). (In French).

The paper describes a single-channel pulse height analyzer, having a resolving time of 12 ns. Two working modes are available, one of which is independent of the input pulse duration. Another feature of the device is the possibility to be converted, with the help of a simple switch, into a pile-up selector. (auth)

16944 RECENT DEVELOPMENTS IN MEASURING SHORT TIME INTERVALS BY TIME-TO-AMPLITUDE CONVERTERS. Ogata, A.; Tao, S. J.; Green, J. H. (New England Inst. for Medical Research, Ridgefield, Conn.). Nucl. Instrum. Methods, 60: 141–50(Mar. 15, 1968). (NYO-3661-9).

A brief and concise survey is given here for the recent developments in measuring short time intervals by time-to-amplitude converters. All the elements involved in the system are discussed individually and attention is paid to their performances and limitations. (auth)

16945 EQUIPMENT FOR THE MEASUREMENT OF ELECTRON SCATTERING AT 180°. Ganichot, D. (Ecole Normale Superieure, Orsay, France); Benaksas, D.; Grossetete, B.; Lorrain, J.; Isabelle, D. B. Nucl. Instrum. Methods, 60: 151–6 (Mar. 15, 1968). (In French).

An experimental set-up for electron scattering studies at 180° is described. The optical properties of the system have been determined from field mapping. As a check we performed an experiment on hydrogen and found that the tail of the elastic peak was modified due to the presence of background electrons. This set-up as with all other systems for measuring electron scattering at 180° includes an auxiliary magnet which is responsible for this background. This effect was demonstrated and we were able to eliminate it. Conclusions are drawn about the general technique of such experiments. (auth)

16946 CORRELATION COUNTING APPLIED TO THE DETERMINATION OF ABSOLUTE DISINTEGRATION RATES. Williams, A.; Sara, R. I. (National Physical Lab., Teddington, Eng.). Nucl. Instrum. Methods, 60: 189–94(Mar. 15, 1968).

The correlation method of measuring coincidence events has been used to measure absolute disintegration rates. In contradiction to previous claims, no advantages over the conventional method have been found. (auth)

16947 DIRECT DIGITAL MONITORING OF CONTROL LOOPS BY COMPUTER. Amblard, J. C.; Joumard, R. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 120, 37–50(Nov. 1967). (In French).

The computerized temperature-regulation system described here was produced for the purpose of studying the problems involved in programming for real-time computer processing and in multiplexed digital control, and to check the validity of the theoretical results obtained with regard to the definition of the polynome corrector to be associated with a given thermal process. The unit has been added to an experimental supervisory system associated with a small number of furnaces, and is the subject of an engineering thesis at the Grenoble Nuclear Research Center and the Grenoble Institut Polytechnique automation laboratory. The experience gained with this prototype will be used in the designing of a supervisory control system for in-pile thermal engineering experiments. (auth)

16948 ON-LINE USE OF A CAE 510 COMPUTER IN TIME-OF-FLIGHT EXPERIMENTS. Cauvin, B.; Ribon, P.; Sanche, M. (CEA, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 120, 83–94(Nov. 1967). (In French).

The experimental aims involving the on-line use of the CAE 510: direct acquisition and primary reduction of data obtained during the measurement of effective neutron cross-sections by the time-of-flight method, at the Saclay linear accelerator are discussed. The installation of the computer and its functions are briefly described, and some of the difficulties encountered are indicated. A first critical survey of the merit and demerits of the system, particularly with reference to programming difficulties, on- or off-line, and the requirements introduced by the system-computer interface, which render computing difficult during acquisition in real time, are presented. (auth)

16949 ADAPTATION OF COMPUTER STRUCTURES FOR THE PROCESSING OF DATA IN NUCLEAR PHYSICS. Ghesquiere, G. L. (Techniques Nouvelles, France). Bull. Inform. Sci. Tech. (Paris), No. 120, 109–14(Nov. 1967). (In French).

On the basis of papers presented by other authors, it is shown that computers used in nuclear physical experiments may be classed in two main categories; those employed as instruments pertaining to the experiment, and those employed for the control and direction of experiments. The present tendency is towards the integration of these functions in a single unit. This is followed by a recapitulation of the functions fulfilled by computers, and by technological considerations relating to these various functions. (auth)

16950 FAST DISCRIMINATOR WITH ZERO CROSSOVER. Ryu, Norio (Hiroshima Univ.). Jap. J. Appl. Phys., 7: 284–7 (Mar. 1968).

A fast discriminator has been designed to discriminate the pulses from a photomultiplier anode. To match the capabilities of recent electronic circuits dealing with fast pulses in nuclear experiments, a precise time information is extracted from the discriminator using the triggering function of an Esaki-diode. This is done by determining the zero-crossing point of pulses formed by adding reflected pulses returning from a coaxial cable connected to the input pulses. The performance of the fast discriminator has been examined by use of simulated pulses similar to those from a photomultiplier anode. The time jitter of output pulses is less than 1 ns over the range of input pulse heights between 8 mA and its discriminating point 0.8 mA. Five outputs are provided of 4 mA in pulse height and about 6 ns in width. Although the output pulses do not have a rectangular form, the rise times at the beginning and the end of the pulses up to 2 mA are about one nanosecond. An attenuator for fast pulses, matching 75 Ω coaxial cables, is also described. (auth)

16951 CALCULATION OF THE MAXIMUM USEFUL CURRENT IN ION AND ELECTRON SELECTORS. Cotte, Maurice (Faculte des Sciences, Paris). Compt. Rend., Ser. A and B, 265: 1388-91(Dec. 18, 1967). (In French).

The maximum useful current of ion and electron selectors was calculated for the case where the electromagnetic field, independent of time, has a symmetry plane. The expressions obtained are applied to two specific electrostatic selectors. (J.S.R.)

16952 AN AUTOMATICAL DATA LOGGING AND PROCESSING SYSTEM FOR EXPERIMENTAL INVESTIGATIONS. I. Naray, Zs. (Zentralforschungsinstitut fuer Physik, Budapest). Kernenergie, 10: 285-92(Oct. 1967). (In German).

In Part I the essential properties of the automatic data logging and processing system developed in the Central Research Institute for Physics (KFKI) in Budapest provided for the use in experimental investigations is described. The system consists of a large number of functional units (various types of converters, stores, peripheral units, etc.), from which measuring devices of various types may be combined. (auth)

16953 THE USE OF A SMALL COMPUTER IN THE ACQUISITION, REDUCTION, AND ANALYSIS OF $\gamma-\gamma$ DIRECTIONAL CORRELATIONS. Daniels, T. (Manchester Univ., Eng.). Nucl. Instrum. Methods, 59: 214-26(Feb. 1968).

Methods of acquiring and analysing two-dimensional data from gamma-gamma correlation experiments are described, and the main features of computer programs written to implement them are presented. The programs were written specifically for a small computer, but incorporate all the techniques required to reduce two-dimensional gamma-ray spectra. (auth)

16954 COUNT-LOSS CORRECTIONS FOR TMC TIME ANALYZERS WITH MODEL 211 LOGIC. Foster, M. R.; Fritsche, R.; Mills, W. R. (Mobil Oil Corp., Dallas). Nucl. Instrum. Methods, 59: 254-60(Feb. 1968).

Time analyzers are used in pulsed neutron research for measuring the distribution of neutrons as a function of time. The measured distribution can differ significantly from the true one when the neutron flux is high. The difference is due to counting losses, the mechanism of which can be modeled by a stochastic process. This makes possible the estimation of the true distribution from the measured data. For the TMC Model 211 time-of-flight logic, estimation formulas are derived and tested against experiment. A useful byproduct is a method for measuring detector dead-time. (auth)

16955 TIME RESOLUTION AND PULSE SHAPES IN ZERO CROSSOVER TIMING. Jones, G.; Orth, P. H. R. (Univ. of British Columbia, Vancouver). Nucl. Instrum. Methods, 59: 309-13(Feb. 1968).

A simple modification of commercial double delay-line amplifiers is described which enables achievement of a significant reduction in the inherent time resolution for a coincidence system employing zero crossover pulse shaping techniques. This improvement in timing resolution is obtained without sacrificing the energy resolution of the system. As an example, a coincidence system composed of two large NaI(Tl) scintillator-5" photomultiplier combinations yielded the following full widths at half maxima for coincident 0.51 MeV annihilation gamma rays: optimum "centroid" leading-edge timing: 7.65 ns, conventional zero crossover timing: 25.5 ns, and modified zero crossover timing: 12.5 ns. (auth)

16956 PULSE HEIGHT COMPENSATOR FOR USE WITH TIME-TO-AMPLITUDE CONVERTERS. Sen, P.; Patro, A. P. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Instrum. Methods, 59: 289-92(Feb. 1968).

A compensation circuit, based on addition of a difference of amplitude of the side channel pulse with the amplitude corresponding to the midpoint of the energy range selected in the side channel, is used for energy compensation in a time measuring system. This reduced the centroid shift with energy and improved the resolution in a time measuring system using 6810A photomultipliers. A resolution of 0.52 nsec with energy selection of 300 to 930 keV in both channels and a slope of the order of 9×10^{-11} sec was obtained. The centroid shift in the energy range is of the order of 3×10^{-11} sec only. (auth)

16957 IMPROVED BASE-LINE STABILIZATION FOR PULSE AMPLIFIERS. Patzelt, R. (SGAE, Seibersdorf, Austria). Nucl. Instrum. Methods, 59: 283-8(Feb. 1968).

The base-line of the output of a dc-coupled pulse amplifier can be held within narrow limits, if a regulator is used that provides a high degree of negative dc-feedback from the output to the input via a low-pass filter. Base-line shifts following a CR-coupling network at the input can be avoided for duty cycles up to 40%, if the regulator-amplifier limits at very low amplitudes. In this case the stabilization circuit reacts not on the arithmetic mean value of the output-signal, but practically on the undisturbed baseline that can be stabilized therefore. A further improvement using a gate within the feedback-path that closes during each input pulse is discussed. The circuit is given in detail: coupled with an amplifier with an output range of ±10 V, the mean value of the baseline is held within ±2 mV at a pulse rate of 10,000 pps (from a NaI-detector) the statistical fluctuations go up to ±5 mV. The dc shift without signal is less than 5mV/day (non cumulative). (auth)

16958 HIGHLY SENSITIVE ELECTROSTATIC PRECIPITATOR WITH NO MOVING PARTS. Teodosic, V. (Danish Atomic Energy Commission, Riso). Nucl. Instrum. Methods, 59: 350-2 (Feb. 1968).

Cross correlation between a modulated precipitation voltage and the corresponding detector voltage variation gives a signal which is proportional to the fission gas concentration even when the precipitation electrode is not moving, which makes it possible to build a simple unit for fuel leakage detection. (auth)

16959 MAGNET SYSTEM FOR 180° ELECTRON SCATTERING. Peterson, G. A. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Instrum. Methods, 59: 341-3(Feb. 1968).

A four-magnet system with constant solid angle and outgoing beam direction for both inelastic and elastic high-resolution 180° electron scattering is described and contrasted with other systems. (auth)

16960 REDUCTION OF THE SHIFT OF THE EQUILIBRIUM REST POTENTIAL BY CAPACITIVE IMPULSE REPEATING. Schuster, H. J. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods, 59: 347-9(Feb. 1968). (In German).

The baseline shift accompanying capacitive transmission of pulses (up to 10 V amplitude, 200 ns width, 400 ns interval) is reduced to less than 3 mV, using a diode and an amplifier. The deviation from linearity is less than 0.1% for pulses of 10 mV up to 10 V. (auth)

16961 TRANSISTORISED TIME-TO-AMPLITUDE CONVERTER FOR POSITRON LIFETIME MEASUREMENTS IN SOLIDS. Bell, J.; Khan, M. N. G. A. (Univ. of New South Wales, Kensington). Nucl. Instrum. Methods, 59: 314-18(Feb. 1968).

A simple transistorized time-to-amplitude converter is described along with the transistorized double coincidence unit. This is based on pulse overlap principle and specially suitable for positron lifetime measurements in non-metallic solids. It has a high time resolution ($W_{1/2}$ = 0.402 ± 0.032 nsec using the upper 25% of the ^{60}Co γ-energy spectra) and overall linearity of 20 nsec with logarithmic slope of 0.078 nsec. This converter may be adopted for work in other relevant fields besides positronium lifetime measurements. (auth)

16962 PROTECTIVE DEVICE FOR PRESSURE GAUGES MEASURING THE PRESSURE OF RADIOACTIVE FLUIDS. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,098,915. Jan. 10, 1968. Priority date Feb. 16, 1965, Germany.

A protective device for a pressure gage for measuring the pressure of radioactive fluids consists of a time delay pipe through which the pressure gage is connected to the measuring chamber. The pipe is of a cross section and length calculated to ensure that the radioactivity of the fluid issuing from the outlet end of the delay pipe is within the permissible radiation level for the gage. The delay pipe may have the form of a coil, a stack of serially connected spiral pipe layers, or a stack of serially connected helical coils. The pressure gage is so located in relation to the delay pipe that it is situated outside the last pipe helix or spiral and is thus shielded by the delay pipe. (B.L.M.)

16963 DEVICE FOR VARIOUS APPLICATIONS OF AN ELECTRON BEAM. Arata, Yoshiak Japanese Patent 1966-14954. Aug. 23, 1966. Filed Apr. 7, 1964.

A device is described which permits various applications of high current-density electron beams, including welding and working of materials, plasma generation, etc. In this device the damage due ion bombardment is reduced. (NSA of Japan)

16964 APPARATUS FOR WORKING MATERIALS WITH A CHARGED PARTICLE BEAM. Tanka, Kazumitsu (to Japan Electron Optics Lab. Co., Ltd.). Japanese Patent 1967-7036. Mar. 22, 1967. Filed Feb. 19, 1964.

By the method proposed, when the working time is short, or the beam current is small, the beam current can be highly stabilized, thereby enabling high-precision working. It includes a detector in the path of a charged-particle beam, which can be removed from the path; a detector, which detects directly the irradiated beam-current; (or either of the two detectors); a device for comparing the signal, due to the detected beam-current, with the standard signal; and a device, for feeding-back the differential signal to the beam-producing system and thereby controlling the emitted charged-particle beam. (NSA of Japan)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 17723.

16965 (CEA-R-3343) COMPORTEMENT DE COMPTEURS A BF_3 APRES IRRADIATION DANS UN REACTEUR. (Behaviour of BF_3 Counters after In-Pile Irradiation). Verdant, Robert (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 30p. (In French). Dep.

The behavior of a proportional BF_3LCT 14 NE 31 counter with aluminum cathode has been studied after irradiation from 10^5 to 10^6 n cm^{-2} in the swimming-pool reactor TRITON. The pulse spectrum was only slightly modified by two successive irradiations at 10^{15} n cm^{-2}, and 1 hour after the end of the irradiation the decrease in sensitivity reached 10 to 20 per cent. One hour after irradiation at 10^{16} n cm^{-2} this decrease was 20 per cent but the pulse spectrum was affected. The advantages of an aluminum cathode with respect to a standard counter using a copper cathode and irradiated under the same conditions are given. (auth)

16966 THEORETICAL STUDY OF THE ENERGY SPECTRA OF CHANNELED PARTICLES. Poizat, Jean-Claude; Remillieux, Joseph; Sarazin, Armand (Univ., Lyon). Compt. Rend., Ser. A and B, 265: 1324-7(Dec. 6, 1967). (In French).

The calculations presented make it possible, by reconstituting the energy spectra of channeled particles transmitted across a monocrystal, to explain the energy loss processes of channeled particles, in particular the component with high energy loss observed experimentally. (auth)

16967 RADIATION DAMAGE IN ANTHRACENE AND PLASTIC SCINTILLATOR BY IRRADIATION WITH ELECTRONS BETWEEN 4 AND 10 keV. Hayen, Juergen (Univ., Goettingen, Ger.). Z. Phys., 210: 182-92(Feb. 12, 1968). (In German).

Plastic scintillators NE 102 A and anthracene crystals were irradiated with electrons having energies between 4 and 10 keV. The fluorescent light was dispersed by a spectrograph and recorded on photographic plates. After excitation by electrons the plastic scintillator emits a phosphorescence band around 5630 Å. The radiation damage of plastic scintillator and of anthracene crystals is described by the same behavior. An absorbed energy of 2.5 eV per molecule of the monomer vinyltoluene is required for plastic scintillators to reduce the fluorescence intensity by a factor of 2. For anthracene crystals 0.3 eV per molecule is required. In the emission spectrum of a damaged anthracene crystal new bands at 5630 and 6380 Å were observed. (auth)

16968 EFFECT OF OXYGEN ADDITIONS ON THE RADIATIVE RECOMBINATION IN SILICON. Bortnik, M. V.; Tkachev, V. D.; Yukhnevich, A. V. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk, No. 3, 93-6 (1967). (In Russian).

The effect of the addition of oxygen on the radiative recombination in silicon, containing radiation defects in the structure, induced by ^{60}Co γ radiation, was investigated. The presence of oxygen in the monocrystal leads to the appearance in the heterogeneous region of band spectra. The intensity of the band depends on the concentration of the oxygen and the concentration of fine admixtures in the monocrystal. The experimental results confirm that the centers, on which the appearance of the bands of mixed emission depends, do not determine the life time of the nonequilibrium carrier in the material. The measurement results of the dependence of the intensity of the self-emission on the irradiation dose and the reduction of the self-emission in annealing processes for materials with different concentrations of oxygen indicate the participation of admixed oxygen atoms in the formation of emissionless centers. (tr-auth)

16969 MECHANISMS OF SECONDARY BACKGROUND BLACKENING OF ION-IRRADIATED PHOTOPLATES. Wagner, H.; Hergt, R. (Univ., Jena, Ger.). Z. Naturforsch., 22A: 1984-9(Dec. 1967). (In German).

The strong secondary underground blackening on photographic plates highly exposed to ion beams in mass spectrometers was investigated. It is found that the most effective components causing the blackening with primary ion currents up to 2×10^{-9} A are: Positively charged ions sputtered from the emulsion surface and secondary electrons released by positive ions impinging on faces opposite to the photographic plate. However, these particles will become effective only if the emulsion is appreciably charged up by the ion current. In the mass spectra produced by our Mattauch-Herzog mass spectrograph the ion component under favourable conditions appears as a secondary mass spectrum, the most intensive lines therein being those of the hydrogen ions. Numerous different ion species could also be identified. Assuming a deflection of the secondary ions through 180° it was possible to calculate their kinetic energies. Thus positive charging up potentials of 1-2 kV with ion currents of 10^{-11} A were measured. For higher currents the charging up is limited by secondary electron backstreaming to roughly 5 kV. (auth)

16970 RADIATION STABILITY OF N-SILICON HALL PICK-UPS. Parfen'eva, L. S.; Sominskii, M. S.; Yur'eva, G. A. Fiz. Tekh. Poluprov., 1: 312-13(1967). (In Russian).

An investigation was made of the effect of 1-MeV electrons on the basic parameters of crystalline n-type Si detectors. The detectors were made from three types of silicon, each having a different resistivity ($\rho_1 = 0.15$, $\rho_2 = 1$, and $\rho_3 = 150$ ohm · cm). The dependence of the input resistance (r_{in}) of the detector and the Hall constant R_H on the radiation dose was determined. The Hall emf at an external potential difference of 1 V, applied to the detector at different times during irradiation, was obtained. Detectors based on the Hall-effect operate mainly in one of two modes: at a given external potential difference V or at a given current I. The detector's reaction to penetrating radiation depends on the mode of operation. For a detector operating at V = const: (1) The Hall emf U_H does not depend on the variation of charge carrier concentration caused by electron irradiation; (2) In the range of integral doses up to 3×10^{15} β/cm^2, U_H remains practically constant; (3) Detectors can operate normally in fields of penetrating radiation during which a possible decrease of U_H is determined only by a decrease of mobility n, which usually suffers insignificant changes. For a detector operating at I = const: (1) With an increase in integral irradiation dose the Hall emf increases. Up to doses of 3×10^{15} β/cm^2 this increase is generally proportional to the increase of Hall constant R_H; (2) Under identical conditions of irradiation the change in detector parameters depends on the concentration of current carriers in the material from which the detectors are prepared: the smaller the concentration the earlier the changes appear and the more significant they are. (ATD)

16971 RADIATION EFFECTS IN SEMICONDUCTOR DEVICES. Larin, Frank. New York, John Wiley and Sons, Inc., 1968. 298p. $11.95.

The physical-electrical relations for semiconductor components without regard to radiation are discussed under the following topics: introduction to radiation effects; physical characteristics of semiconductor devices; semiconductor properties at low injection; low injection diode characteristics; low injection transistor characteristics; effects of high injection in semiconductors; measurements for physical characteristics and equivalent circuit parameters; and characteristics of additional semiconductor devices such as power diodes, solar cells, integrated circuits, silicon-controlled rectifiers, and field-effect transistors. Finally, the operation of semiconductor devices in a radiation environment and its effect on performance are described under the following topics: descriptions of nuclear radiation, displacement effects in silicon devices, transient damage effects in silicon devices, and surface damage effects to silicon transistors. (B.G.D.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

16972 (COO-1287-5) THE BIOSYNTHESIS OF CHLOROPHYLL IN RELATION TO IRON AND ENZYME SYSTEMS. Technical Progress Report, May 1, 1967–April 30, 1968. [Miller, Gene W.] (Utah State Univ., Logan). Contract AT(11-1)-1287. 45p. Dep. CFSTI.

The effects of the following factors on the activity of aminolevulinic acid dehydrase were studied: time of incubation, substrate concentration, protein concentration, pH, EDTA, and ferrous ions. Experiments on ALA synthetase in higher plants were initiated. Methods of extracting the enzyme from leaf tissue of spinach are described and assay was attained by using succinic-^{14}C as substrate and separating ALA-^{14}C by column chromatography. Radioactivity of the isolated compounds was determined by using a Tricarb Liquid Scintillation Spectrometer. Methods of preparation of isotopic porphyrins and of succinyl-coenzyme A are described. The results suggest that one of the major requirements for iron in chlorophyll and other porphyrin syntheses in higher plants is at the ALA synthetase reaction. A further requirement for iron is implied by the increased incorporation of ALA-^{14}C into porphyrins in the presence of iron. Two methods of purification were used to prepare coproporphyrinogenase from tobacco leaves. Using the first method, the enzyme was very diluted during purification and a high activation effect of iron was not observed. The enzyme prepared using the second method was highly concentrated. Enzyme activity was greatly enhanced by increasing iron concentration. A maximum activation of 2.3 fold over the control was obtained. Iron was considered to be an activator in these experiments. (H.L.W.)

16973 (NYO-3247-4) TRACING LIFE PROCESSES WITH RADIOISOTOPES. EXPERIMENTS IN BIOLOGICAL SCIENCE. Hurlburt, Evelyn M. (Montgomery Junior Coll., Takoma Park, Md.). Oct. 1967. Contract AT(30-1)-3247. 93p. Dep. CFSTI.

Twelve experiments suitable for undergraduate college courses in biology are included. Detailed procedures and suggestions are given for each experiment. Organisms utilized in the experiments include bacteria, yeasts, planarians, clams, and rats. The isotopes utilized are ^{45}Ca, ^{51}Cr, ^{59}Fe, ^{131}I, ^{32}P, and ^{35}S. Appendices giving instructions for preparation of special materials and reagents and sources of information on licensing regulations and radiation protections standards are included. (H.L.W.)

16974 (ORO-2832-56) RADIATION AND BIOPHYSICAL STUDIES ON VIRUSES AND CELLS. Progress Report, November 11, 1966–October 11, 1967. Shalek, Robert J. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.). Contract AT(40-1)-2832. 63p. Dep. CFSTI.

The effects of ionizing radiation on the structure of chromosomes were studied by means of light and electron microscopy. Effects observed with the light microscope included loss of integrity of normal swelling-condensation responses, changes in organization, and loss of material. Technical modifications and improvements in electron microscope techniques are described. These include the use of high resolution stereo sample holders, keyed specimen grids, and Anderson critical point drying. Ultracentrifuge equilibrium molecular weight determinations were made on lysozyme, ribonuclease, tobacco mosaic virus protein, myoglobin, hemoglobin, and papain. Studies were begun on the formation of nucleoprotein complexes from purified histone fractions and calf thymus DNA. DNA was drastically reduced in size by sonication in order to diminish opportunity for nucleoprotein particle interaction. The effects of x radiation on DNA from reconstituted nucleohistones were studied; results are presented in the form of tables and graphs. Chain lengths of DNA isolated from mitotic chromosomes of hamster cells were measured by means of electron microscopy in combination with computer techniques. The effects of ionizing radiation on the molecular weight distribution of DNA were studied using 250 kvp x rays. To determine the length of very large DNA molecules a digital readout system was incorporated into the electron microscope. Results are shown by means of figures and graphs. The size of T_2 bacteriophage DNA irradiated within free phage and within host-phage complex was determined. Preliminary analyses suggest that there are more than twice as many double stranded breaks per unit length per rad in T_2 DNA than in mammalian DNA irradiated as isolated chromosomes. Radiosensitive structures were studied using electron particle beams of low penetration. The design and construction of the apparatus are described. Initial studies using hamster cells indicate that a radiosensitive region is contained in a thin peripheral shell. The effects of x radiation on membrane permeability and the transport system of hamster cells were studied. Results were consistent with the assumption that the nuclear membrane was permeable to tritium-labeled thymidine only during the S (DNA synthetic period) phase of the cell cycle. Studies on ferrous sulfate chemical dosimetry for the measurement of high energy photons and electrons were continued. The uv induction sensitivity of *Escherichia coli* was determined, and the number of cells surviving both uv inactivation and lysis caused by induction of the prophage was measured. The rate of DNA synthesis in *E. coli* was measured throughout the division cycle for the synchronized cell population by following the uptake of tritium-labeled thymidine for four minutes. The rate of DNA synthesis was observed to be constant for the first half of the division cycle and then to abruptly increase in the latter of the division cycle. A list of publications and papers presented resulting from this research during the period November 11, 1966, to October 11, 1967, is presented. (H.L.W.)

16975 DESTRUCTION OF BACTERIAL PYROGENS BY PHYSICAL PROCEDURES. Lange, Aloisie (Humboldt Univ., Berlin). Wiss. Z. Humboldt Univ. Berlin, Math.-Naturwiss. Reihe, 16: 155-8(1967). (In German).

When a sterile pyrogen-containing filtrate from a culture of *Serratia marcescens* contained in 1-ml ampoules was irradiated with β particles of 1.6-MeV energy, a dose of 10^7 to 10^8 Rad was required to produce inactivation. The pyrogenic effect, as measured by tests in guinea pigs, was almost as great as with the control samples even when doses of 2.5×10^6 Rad were given for up to 3 hr. The pyrogenic effects were reduced somewhat after 5×10^6 Rad (3 hr). No differences were found in the pyrogenic effects of nonbacterial Na nucleinate pyrogen at any dose from 2.5×10^6 to 10^8 Rad, after exposure for 3 hr. The effects of γ irradiation on the Serratia pyrogen were about the same. Inactivation was produced over a range of doses from 1.1×10^7 to 5×10^7 Rad. No effects were observed when nonbacterial Na nucleinate pyrogen was exposed to this range of doses. The results suggested that the effect of ionizing irradiation was due to molecular alterations of the pyrogen. (BBB)

16976 STUDIES ON THE ANALYSIS OF DRUGS BY USE OF ISOTOPES. IV. REVERSE DILUTION ANALYSIS OF THE METABOLITES OF ^{14}C-EPHEDRINE. Nagase, Yuzo; Baba, Shigeo (Tokyo Coll. of Pharmacy). Yakugaku Zasshi, 87: 123-8(Feb. 1967). (In Japanese).

The rate of ephedrine excretion into urine was examined by intraperitoneal injection of ^{14}C-labeled d- and l-ephedrine into rats. Metabolic products in the urine were examined by paper chromatography combined with reverse dilution analysis. The l-compound was demethylated or hydroxylated in the p-position in vivo but the d-compound did not undergo these changes. Hippuric acid and a small amount of benzoic acid as well as a fair amount of nonidentified carboxylic acid and a neutral product were detected as the metabolites. (auth) (NSA of Japan)

16977 THE MOESSBAUER EFFECT FROM BONE CRYSTAL SURFACES. Marshall, J. H. (Argonne National Lab., Ill.). Phys. Med. Biol., 13: 15-22(Jan. 1968).

The first alkaline earth radioisotope to yield the Moessbauer effect, ^{133}Ba$-^{133}$Cs, was used to study the mechanism of ion uptake on bone crystals. The Moessbauer effect is explained, together with this new application. A source of ^{133}Ba was deposited on the surfaces of crystals of bone extracted by ethylene diamine. The Moessbauer velocity spectrum was compared with that of ^{133}BaCl$_2$ and ^{133}BaAl$_4$. The absence of a significant difference is discussed. (auth)

16978 THE EFFECT OF ULTRAVIOLET LIGHT ON THE HYDROGENASE OF PROTEUS VULGARIS. Purec, Ljerka; Krasna, Alvin I. (Columbia Univ., New York). Biochemistry, 7: 51-5(Jan. 1968).

The hydrogenase activity of *Proteus vulgaris* can be activated by irradiation with light of wavelength 2537 Å. This activation is dependent on the light intensity and persists after the irradiation is terminated and the gas phase is replaced with a new sample of gas. The hydrogenase remains activated after exposure to air. The activation also occurs in the presence of carbon monoxide and is due to activation of the residual active enzyme and not to a reversal of the CO inhibition. Prolonged irradiation with ultraviolet light leads to inactivation of the hydrogenase. With the light intensities employed, visible light had a greater activating effect than ultraviolet light. A short-term irradiation with visible or ultraviolet light activates hydrogenase if the enzyme is in the active deoxygenated form during irradiation. (auth)

16979 CONCERNING THE NATURE OF ACTION OF IONIZING RADIATION ON SOME METABOLIC PROCESSES IN MAMMALS. Graevskaya, B. M. pp 102-28 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

Analyses of disorders of protein and carbohydrate metabolism were made using experimental data and data from the literature. Similar analyses of catecholamine metabolism were made. The results indicated that the remote effects of ionizing radiation were of far greater significance than structural disturbances for radioinduced biochemical changes. The decreased efficiency of protective agents in radioinduced metabolism disorders is also explained by the results. (H.L.W.)

16980 GAS EXCHANGE, GROWTH AND BIOCHEMICAL REACTIONS IN PHYCOMYCES BLAKESLEEANUS. Forssberg, A.; Brummer, R.; Pehap, A. (Karolinska Inst., Stockholm). Radiat. Bot., 7: 507-12(Dec. 1967).

X-irradiation with exposures not in excess of a few hundred R were found to cause growth rate and biochemical reactions in the sporangiophore of Phycomyces. All reactions were reversible within 10 min, and no cells killed or seriously damaged. Experimental evidence suggests that the primary irradiation effects are an influence on the intracellular oxygen consumption, the oxidative phosphorylation, and growth, which are closely connected. The growth and the intracellular oxygen concentration decrease at about the same rate, and reach minimum values 2 to 4 min after the irradiation. The oxygen is partly consumed in oxidative phosphorylation, as seen from the immediate increase of energy-rich phosphates. This stage is followed by an increase of growth and replenishment of the oxygen, facilitated by air diffusion through the cell walls. The phosphates are used up in further cellular reactions. Secondary reactions, and consequences of the oxygen changes are an increase of free SH-groups, coincident with the minimum of oxygen concentration and of auxin, a few minutes later. It is shown that oxidative reactions occur in the particle fraction only, whereas the reversibility of the reaction needs the presence of the supernatant cytoplasma. (auth)(UK)

16981 EFFECT OF IONIZING RADIATION ON OXIDATIVE PHOSPHORYLATION IN TISSUE MITOCHONDRIA. Mokharava, S. I. Vestsi Akad. Navuk BSSR, Ser. Biol. Navuk, No. 1, 27-33(1967). (In Russian).

In the total irradiation of white rats with x rays in a dose of 40 R and with neutrons of intermediate energies (about 13 rad) disturbances were discovered in the processes of phosphorylation and respiration in the mitochondria of the liver, kidneys, and myocardium on the 1st, 5th, 15th, and 30th days after irradiation. In neutron irradiation using succinic acid as the oxidative substratum the most intense phosphorylation and respiration in the liver occurred on the 5th day; on the 30th day there was reduction of esterification of inorganic phosphate and O_2 consumption in the kidneys. No changes were observed in cardiac sarcomas after this type of irradiation. With the use of α-ketoglutaric acid as the oxidative substratum the liver displayed increased phosphorylation and absorption of oxygen on the 1st, and a decrease on the 30th day after irradiation. In the kidneys the level of phosphorylation and respiration was reduced on the 15th and 30th days. Oxygen consumption in the cardiac muscle increased on the 1st day. In experiments with liver mitochondria in which glutamic acid was the substratum decreased phosphorylation was observed, beginning with the 5th day, with the peak of this reduction of the 30th day. In the same period the intensity of respiration made its deepest descent. No reliable changes in the studied processes were noted in kidney mitochondria after neutron irradiation. In x irradiation the trend in respiration and phosphorylation changes in these tissues remained the same, but it was more clearly manifest, as a large number of reliable data attest. Normalization of the processes studied had not set in by the end of the observation period. (ATD)

16982 SERIAL BRAIN SCANNING USING ^{99m}Tc IN PATIENTS WITH CEREBRAL INFARCTION. Molinari, G. F.; Piercher, F.; Heyman, A. (Duke Univ., Durham, N. C.). Neurology, 17: 627-36(July 1967).

There are few reports on multiple scans after cerebral infarction largely because of the risk of radiation exposure associated with the long half life of the radioisotope used. The relatively short half life of and low radiation exposure from ^{99m}Tc, a γ-emitting isotope, permit serial scans during the development and resolution of the cerebral infarction. In 20 patients with cerebral infarction serial brain scans were performed using repeated injections of ^{99m}Tc during the course of the illness. An intravenous injection of 4 to 10 mCi of ^{99m}Tc was given and lateral scan of the involved cerebral hemispheres was taken within a few minutes, usually followed by a repeat scan 45 min later. Abnormal areas of increased radioactivity were observed in only four patients (27%) who had their initial scans within seven days after the onset of neurologic symptoms, but 15 (75%) had one or more abnormal scans during the course of their illness. Patterns of isotope localization are described. An extensive, irregularly shaped area of abnormal radioactivity contrasting markedly with the surrounding brain tissues was observed in eight patients. On the lateral scan, each of them showed an elongated area of radioactivity that corresponded roughly to the distribution of the middle cerebral artery. The results indicated a definite relation between duration of infarction and abnormal localization of ^{99m}Tc. Most of the patients developed abnormal radioisotope activity during the second to fourth weeks of illness. (BBB)

16983 EFFECTS OF SHORT-TERM IRRADIATION ON POTENTIAL, THRESHOLD OF ELECTRICAL STIMULATION, AND RESISTANCE OF THE CELL MEMBRANE OF NITELLA FLEXILIS. Hansen, U.-P. (Institut fuer Angewandte Physik, Kiel). Atomkernenergie, 12: 447-62(1967). (In German).

Results of investigations on cell membranes showed that the phenomena of resting potential, threshold of stimulation, and resistance are related and can be explained by passive permeability of the plasmalemma. The opinion that irradiation interferes with the mechanism of the Hodgkin and Huxley theory is discussed. This would mean that the permeability of the chloride ions only is increased (below 30 mV). Experiments were conducted to determine the validity of the hypothesis of Vanselow. Certain peculiarities were demonstrated, e.g., very slow oscillations of the resting potential lasting for several hours. (auth)

16984 RADIORESISTANT NATURE OF THE TRANSFORMING ACTIVITY OF DNA IN BACTERIAL SPORES. Tanooka, Hiroshi; Sakakibara, Yoshimasa (National Cancer Center Research Inst., Tsukiji, Japan. Tokyo Univ.). Biochim. Biophys. Acta, 155: 130-42(Jan. 29, 1968).

The radiosensitivity of the transforming ability of the DNA purified from Bacillus subtilis spores showed no difference from that of vegetative cells when irradiated with 6 MeV electrons in the dry state in the presence or absence of oxygen or in saline solution. The transforming ability of intracellular DNA and the colony-forming ability of intact spores showed higher radioresistance than the same abilities of vegetative cells. The radioresistance of the transforming DNA in intact spores remained unchanged in spheroplasts of spore. The radioresistance of the DNA, however, was markedly lowered when the spheroplasts of spore were osmotically ruptured. Mixing purified DNA with the homogenate of spores increased the radioresistance of the DNA but not to a level as high as that of DNA in intact spores. An increase of radiosensitivity caused by irradiation in the presence of oxygen was found in both the transforming ability of intracellular DNA and the colony-forming ability of intact spores but not in the same abilities of vegetative cells in the dry state. The results indicate that: the structure of the spore plays an important role in the resistance of spore intracellular DNA to ionizing radiation, spore-specific chemical protection is partly responsible for radioresistance, and the repair activity is not involved. (auth)

16985 EXPERIMENTAL MURINE AMYLOIDOSIS IN X-IRRADIATED RECIPIENTS OF SPLEEN HOMOGENATES OR SERUM FROM SENSITIZED DONORS. Janigan, David T.; Druet, Robert L. (Dalhousie Univ., Halifax, Can.). Amer. J. Pathol., 52: 381-90 (Feb. 1968).

Inbred C_3H mice were injected daily with a soluble protein antigen azocasein, for a period of time that fell short of that required for the development of amyloidosis. Spleen, either intact cells or as crude, frozen-thawed homogenate, or serum from these mice was transferred into sublethally or lethally x-irradiated isogeneic or allogeneic recipients. The latter developed amyloidosis following a much shorter sequence of injections with azocasein. The amyloid deposits were spatially related to fixed RE cells. No amyloidosis developed in recipients of nonsensitized spleen tissues or serum. These results confirm previous studies indicating that lymphoreticular cells of sensitized donors play an important rate-limiting role in amyloidogenesis, and show that nonviable cells or serum have the same capacity. It is concluded that amyloidosis resulted from an interplay of a subcellular product from lymphoreticullar cells of sensitized donors with the RE cells of the recipients, and that the latter cells, at the least, determined the final location of amyloid fibers. The possible nature of the components and features of the interplay are briefly considered. (auth)

16986 EFFECT OF γ-IRRADIATION ON SOME ENZYMES ACTIVE IN THE SYNTHESIS OF DNA. Budilova, E. V. Radiobiologiya, 7: 323-7(1967). (In Russian).

Actinomycin D administered to rats 1 hour after hepatectomy suppressed almost entirely in the regenerating liver increases in the activity of deaminase (I) of deoxycytidylic acid 48 hrs after the operation and 24 hrs after the operation of activity kinases (II) that phosphorylate thymidine. Under the effect of this antibiotic, inhibition of the synthesis of I and II in microsomes of liver cells took place. Gamma-irradiation of the animals at a dose of 1000 R 1 hr after hepatectomy suppressed subsequent increases in the activity of I and II. Administration of actinomycin D to control animals with an intact liver 1 hr before analysis or irradiation of animals 1 hr before analysis had no effect on the activity of I or II. The results indicated that irradiation interfered with the formation of I and II in the regenerating liver rather than with the enzymatic reactions. (JPRS)

16987 THE RADIOACTIVE COBALTICYANIDE ION $^{60}Co(CN)_6^{3-}$ AS AN EXTRACELLULAR MARKER IN SMOOTH MUSCLE. Goodford, P. J. (London Hospital Medical Coll.). J. Physiol. (London), 191: 111P(July 1967).

A method is described for using ^{60}Co-labeled-sodium cobalticyanide to estimate the size of the extracellular space of smooth muscle. The triple negative charge of the cobalticyanide ion, $^{60}Co(CN)_6^{3-}$, tended to prevent uptake by the cells, and its first hydrolysis product, $^{60}Co(CN)_5H_2O^{2-}$, was anionic to the same effect. The ^{60}Co content of the smooth muscle of the guinea pig *taenia coli* at 35°C increased slowly over a period of several *hours in vitro*. Extrapolation back to zero time revealed that the extracellular space of this smooth muscle was 500 ml per kG fresh wet weight. No explanation was offered for this high value. (TSS) (BBB)

16988 STUDIES ON THE DISTRIBUTION OF RADIOISOTOPES BY WHOLE BODY AUTORADIOGRAPHY. XI. DISTRIBUTION OF ^{35}S-LABELED GLUTATHIONE IN MICE. Takahashi, Tadao; Sato, Yoshishige (Tanabe Seiyaku Co., Ltd., Japan). Radioisotopes (Tokyo), 17: 1-9(Jan. 1968). (In Japanese).

The distribution of intravenously injected ^{35}S-glutathione in male and pregnant mice has been studied by whole body autoradiography The radioactivity was rapidly accumulated in the liver, renal cortex, pancreas, salivary glands, gastric mucosa and the intestinal mucosa. The uptake of the isotope into brain occurred slowly and the radioactivity at 7 days after injection increased to the same level as that in the skeletal muscle. The radioactivity in the maternal tissues reached highest 3 hours after injection, whereas those in the fetuses increased gradually until 24 hours. Higher accumulation was observed in the bone, liver, eye and the brain of fetus. (auth)

16989 IN VIVO EFFECT OF UNCOUPLING AGENTS ON THE INCORPORATION OF CALCIUM AND STRONTIUM INTO MITOCHONDRIA AND OTHER SUBCELLULAR FRACTIONS OF RAT LIVER. Carafoli, E. (Univ., Modena, Italy). J. Gen. Physiol., 50: 1849-64(Aug. 1967).

The effect of parenterally administered uncouplers of oxidative phosphorylation on the distribution of injected radioactive Ca and Sr in subcellular fractions of rat liver was studied. After injection of 10 μCi of ^{45}Ca or 20 μCi of ^{89}Sr into rats, most of the radioactivity in the liver cell was associated with the subcellular structures, only negligible amounts of it being found in the soluble hyaloplasm. About 50% or more of the ^{45}Ca and ^{89}Sr in the liver cell was recovered in the mitochondrial fraction. The sp act. of Ca after injection of ^{45}Ca was far greater in mitochondria than in microsomes. Pretreatment of the rats with uncouplers of oxidative phosphorylation (pentachlorophenol and dinitrophenol) markedly decreased the amount of radioactivity associated with the mitochondrial fraction. However, the amount of radioactivity recovered in the microsomes and in the final supernatant increased. These effects were noted only when mitochondrial oxidative phosphorylation was completely uncoupled. The Ca content of mitochondria from the livers of rats pretreated with uncouplers was sharply decreased with respect to the controls. It is concluded that in the liver cells of the intact animal energy-linked movements of Ca and Sr take place in mitochondria. (BBB)

16990 THE INFLUENCE ON STEM CELLS OF STREPTOKINASE–STREPTODORNASE (SK–SD), ε–AMINOCAPROIC ACID (EACA), PENTOSANPOLYSULFOESTER, AND EXTRACTUM SANGUINA DEPROTEINISATUM WHICH HAVE BEEN IRRADIATED WITH X RAYS. (PRELIMINARY REPORT). Szirmai, E. (Technische Hochschule, Stuttgart); Hajdukovic, S. Nucl. Hematol. (Publ. Nucl. Energy), 6: 95(May–June 1967).

Two separate experiments were performed using dogs, rabbits, and rats. In the first experiment, the animals were treated with streptokinase–streptodornase (SK–SD), ε–aminocaproic acid, pentosanpolysulfoester (SP 54), and extractum sanguinis deproteinisatum (Solcoseryl, or Actyhaemyl), none of which had been irradiated. In the second, the animals were again treated with the same compounds, all of which were x-irradiated at a 1200-R dose. The animals were treated for seven days, after which time the effect of the treatment on the myeloid stem cells was analyzed. The results indicated that the stem cells were very radiosensitive. Neither the irradiated nor the nonirradiated materials appeared to influence significantly the time of formation of stem cells. Nor did they affect the average time taken for a given cell to pass from the bone marrow to the peripheral blood (transit time). In general, it appeared that the transit time was faster in smaller animals than in larger animals. (BBB)

16991 RADIATION STIMULATED INCORPORATION OF THYMIDINE INTO THE DNA OF HUMAN LYMPHOCYTES. Evans, R. G.; Norman, A. (Univ. of California, Los Angeles). Nature (London), 217: 455-6(Feb. 3, 1968).

It was found, in the studies described, that radiation-stimulated incorporation of thymidine into the DNA of human blood lymphocytes occurred to the extent of about 90% of the cells following uv irradiation of 25 to 400 ergs/mm^2. The process was not inhibited by hydroxyurea, which inhibits normal DNA synthesis at the concentrations employed, and it also occurred in the absence of phytohemagglutinin or other mitogens. The process could be readily demonstrated after exposure to as little as 25 ergs/mm^2 uv light, a dose which inactivates less than 30% of the lymphocytes. Irradiation was with a uv lamp delivering the bulk of its radiation at 2537Å, with an intensity of ~5 ergs/mm^2/sec. The experimental technique is described, in detail, and results are tabulated and shown graphically. Less than 0.2% of the cells incorporated thymidine in the absence of radiation. Incorporation occurred with no apparent delay following irradiation, and was essentially complete at 6 hr. Doses of ionizing radiation of 1 to 16 kR also resulted in clearly demonstrable thymidine incorporation. The number of thymidine molecules incorporated per cell per rad following 1kR in a 2 hr. incubation period was three—a number similar to the calculated number of single strand breaks per rad in the DNA of human lymphocytes. (UK)

16992 CHEMICAL STUDY ON UNSATURATED FATTY ACIDS OBTAINED FROM PHOSPHOLIPIDS OF A X-RAYS IRRADIATED RABBITS' ORGANS. Ishikawa, Nobuo (Hoshi Coll. of Pharmacy, Japan); Hosaka, Yasutaro. Yakugaku Kenkyu, 37: 372-7(Dec. 1966). (In Japanese).

Attempts were made to find a difference between unsaturated fatty acids extracted from organs of x-irradiated rabbits and those from non-irradiated ones. Fatty acids were isolated from both extracts in pure state and extracts oxidized with $KMnO_4$. The mono- and di-carboxylic acids obtained were investigated by gas chromatography. The results suggest that the former undergoes not only a formation of new double bonds but also migration as well as conjugation of double bond. (auth) (NSA of Japan)

16993 SUSTAINED, LOCALLY-APPLIED BETA RADIATION IN EXPERIMENTAL NERVE REPAIR. Perl, John I. (Augustana Hospital, Chicago). Int. Surg., 46: 419-37(Nov. 1966).

The following experimental preparations were used to investigate the effect of sustained irradiation by a β-emitting isotope on peripheral nerve repairs: bilateral primary nerve suture, 35 dogs; bilateral nonsuture repair with methyl-2-cyanoacrylate adhesive, 24 dogs and 28 rabbits; bilateral autograft, 19 dogs; bilateral homograft of the tibial or of the peroneal components of the sciatic nerve, 32 dogs. In each animal, colloidal $Cr^{32}PO_4$ was deposited by one of several ways at the left nerve repair, and an identical procedure without the radioisotope was carried out on the right side, each animal serving as his own control. Either a rayon sleeve impregnated with ^{32}P was placed at the repair site, or it was directly injected into nerve stumps or grafts. The ^{32}P dose varied from 0.2 to 10 μCi per repair site. In animals in which a radioactive rayon sleeve was used, generally more perineural adhesions and less intraneural scarring were noted than on the control (nonirradiated) side. The myelinated fibers distal to the repair site appeared to be depressed on the irradiated side. The same effects were even more evident in the methyl-2-cyanoacrylate adhesive group. Repairs using the adhesive without radiation also showed less functional and histologic recovery than control suture repairs in other animals. This adhesive enhances tissue reaction and combines with ionizing radiation to interfere with nerve fiber generation. In contrast, when ^{32}P was injected into the nerve stump or into the grafts, there was less perineural and intraneural scar and the mature myelinated fiber population distal to the repair was higher on the irradiated side than on the control side. The difference was particularly evident when the isotope dose was below 2.7 μCi per site. Doses higher than 2.7 μCi depressed axonal regeneration, even with the injection method. With homograft repairs, remarkable functional recovery and axonal regeneration were observed bilaterally when the isotope was injected into the one graft and isotonic saline into the contralateral graft. It was hypothesized that a radioinduced transplant tolerance was responsible for the extraordinary neural regeneration. A theoretical explanation for the suppressive effect of the sustained β radiation on immune reaction against the homografts was offered. (BBB)

16994 OXIDATIVE PHOSPHORYLATION CHANGES IN CEREBRAL HEMISPHERES DURING NEUTRON AND X IRRADIATION. Mokhoreva, S. I. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk BSSR, 11: 65-7(Jan. 1967). (In Russian).

Groups of adult white mice weighing 170 to 240 g were x-irradiated with a 40 R dose or were irradiated with an intermediate neutron dose of about 13 rads to determine the effects of radiation on oxidative phosphorylation in brain mitochondria. Animals were investigated on the 1st, 5th, 15th, and 30th days following irradiation. The brain mitochondria were isolated and all operations prior to incubation were conducted at 0 to 2°C. Succinic acid, α-ketoglutaric acid, and glutamic acid were used as oxidative substrates. Mitochondrial respiration was measured by a manometric method in a Warburg apparatus at 30°C for a 20-min period. Evaluation of phosphorylation was based on inorganic phosphate level differences of the control and incubated samples per 10 mg of mitochondrial protein. Results showed that neutron and x irradiation both depress oxidative phosphorylation processes in brain mitochondria, but not in the same way. It was also shown that the nature of the oxidative phosphorylation changes depends on the substrate used. (auth) (ATD)

16995 PHOTOREACTIONS AT 3655 A BETWEEN PYRIMIDINE BASES AND SKIN-PHOTOSENSITIZING FUROCOUMARINS. Musajo, L.; Bordin, F.; Caporale, G.; Marciani, S.; Rigatti, G. (Univ., Padua). Photochem. Photobiol., 6: 711-19(Oct. 1967).

The mechanism of the photoreaction that took place between DNA and skin-photosensitizing furocoumarins following uv irradiation was examined. After irradiation at 3655 Å of an aqueous frozen solution containing thymine and psoralen, a new photocompound was isolated by column chromatography. It contained a furocoumarin and a pyrimidine moiety linked together by the formation of a cyclobutane ring. After irradiation at 2537 Å in acetic acid solution, the photocompound broke up, yielding psoralen and thymine. From an aqueous frozen solution containing cytosine and psoralen irradiated at 3655 Å, an analogous photocompound was obtained, which, however, consisted of the addition to psoralen of a uracil molecule, instead of cytosine. The hydrolytic deamination of the cytosine moiety to uracil evidently took place in aqueous solution after irradiation. Substances with properties similar to those described above were obtained from bergapten (4-methoxypsoralen) and thymine, from psoralen and thymidine or thymidylic acid, irradiated at 3655 Å. The new substances could be considered as model compounds in explaining the photoreactions that took place between the skin-photosensitizing furocourmarins and DNA upon irradiation at 3655 Å. (BBB)

16996 DIRECTIONAL ACTIVATION OF MIXED LYMPHOCYTE CULTURES (A PRELIMINARY REPORT). Ceppellini, R.; Franceschini, P.; Miggiano, V. C.; Tridente, G. (Univ., Turin). Ser. Haematol., 11: 225-8(1965).

A practical method was sought for histocompatibility testing which allowed detection of the direction of activation in mixed lymphocyte cultures. It would be of great advantage if a unidirectional activation of lymphocytes of one individual against the other could be easily obtained. For a more accurate prediction of the results of homotransplantation the test should be able to distinguish reactivity of graft recipients against prospective graft donors from reactivity in the opposite direction. A dose of x rays was sought which would block mitosis without completely inhibiting cell metabolism. Under the conditions used for irradiation a dose around 1000 R was found necessary to reduce to $\frac{1}{20}$th the percentage of mitoses induced by phytohemagglutinin (PHA). However, lymphocytes irradiated with 1000 R, when mixed with nonirradiated lymphocytes of another individual, were still able to activate this second population. On the basis of these results, some radiomimetic drugs were tested which might be as efficient as x rays and more convenient from the logistic point of view. It was shown that 5 μg/ml of Cloramin prevented most lymphocyte samples from being activated by usual doses of PHA added to the culture 60 hr after Cloramin. In mixed cultures of two lymphocyte populations, both treated with the drug, no activation was observed. The new method described was based on the inactivation of one of the two lymphocyte populations, by prior treatment with Cloramin, while the other was still able to be stimulated as judged by ^{3}H-thymidine incorporation. Mixed lymphocyte cultures from 10 pairs of subjects of different sex were studied on the basis of number of mitotic figures and classified according to sex chromosomes. In all cases, both lymphocyte populations gave rise to mitoses, but the degree of activation in eight out of 10 pairs was significantly different from 50%. (BBB)

16997 BIOLOGISCHE EFFECTEN VAN NEUTRONEN. (Biological Effects of Neutrons). Nederlands Atoomforum, Conference, Utrecht, Mar. 15, 1966. Davids, J. A. G.; van der Feer, Y.; Broerse, J. J.; Barendsen, G. W.; de Zeeuw, D.; Contant, R. B.; Atkins, Harold L.; van Bekkum, D. W. Mededeling No. 24. The Hague, Reactor Centrum Nederland, 1967. 172p. (CONF-660312).

Papers were presented at the conference on: properties of neutrons and neutron sources for biological use; dosimetry of neutrons for radiobiological studies; biophysical aspects of the effects of neutrons on living cells; effects of fast neutrons on animals; use of neutrons in radiobotanical and industrial research in the Euratom-ITAL association; problems of neutron capture therapy; and possibilities of utilization of neutrons in radiotherapy of tumors. (H.L.W.)

Ecology

Refer also to abstract 17053.

16998 (BNWL-SA-1449) METHOD FOR CALCULATING HUMAN RADIATION DOSES IN THE ENVIRONMENT. Essig, T. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 5, 1968. Contract AT(45-1)-1830. 13p. (CONF-680108-3). Dep. CFSTI.

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga.

Several steps are required in computing radiation doses received by persons living in the environs of a nuclear facility. Determination of the kinds and quantities of beverages and foods consumed by residents of the environs of a nuclear facility is a mandatory first step in radiation dose estimates. At Hanford, dietary levels were determined from surveys conducted throughout the United States by governmental agencies, as well as from local estimates. Dietary data from various surveys were compared and values selected were felt to: represent an upper bound to diets of a critical population group (fisherman-farmer) and provide a conservative estimate of average diets of the local population (typical Richland resident). Next, the annual average radionuclide concentrations in several environmental media are routinely determined. At Hanford, for example, these radionuclides and media are: ^{24}Na, ^{32}P, ^{51}Cr, ^{65}Zn, ^{76}As, ^{239}Np, etc. in drinking water; ^{32}P and ^{65}Zn in milk, Columbia River fish, vegetables, fruits, and various types of meat; and ^{131}I in milk, fresh leafy vegetables and drinking water. Radiation dose factors (in units of mrem/microcurie intake) are then computed from MPC_w for several radionuclides, permissible dose rates for several body organs, and ICRP standard man water intake data. Each of these dose factors must be then multiplied in turn by the intakes of each radionuclide in the diet. Radiation doses resulting from consumption of several foodstuffs are then added to determine annual internal radiation doses to specific organs for two population groups. To these internal radiation doses are added the external radiation doses received from recreational use of the Columbia River, thus providing a complete estimate of radiation doses received from Hanford environmental sources. (auth)

16999 (BNWL-SA-1451) A STATISTICAL STUDY OF THE HABITS OF FISHERMEN UTILIZING THE COLUMBIA RIVER BELOW HANFORD. Soldat, J. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 5, 1968. Contract AT(45-1)-1830. 16p. (CONF-680108-7). Dep. CFSTI.

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga.

One method of demonstrating compliance with standards governing environmental radiation exposure is to determine that the exposure to a critical population group is less than a maximum allowable amount specified. Careful characterization of living and dietary habits of this group is necessary to ensure proper assessment of the potential radiation dose. The critical population group residing in the vicinity of the Hanford Project includes those individuals who consume large amounts of Columbia River fish and local game birds. Assumptions currently used for calculation of environmental radiation doses include the consumption of 200 meals per year of Columbia River fish and a total of 500 hours of river bank exposure to catch these fish. A statistical survey was designed for studying the habits of fishermen utilizing the Columbia River below Hanford. During the twelve-month period covered by the survey, over 2,100 fishermen were contacted. About two-thirds of these interviews provided sufficiently complete data to provide statistics for purposes of extrapolation to a description of the entire population of fishermen. Results obtained included number and types of fish caught, number of fishing trips per year, age, and occupation of the fishermen, and fish consumption patterns. (auth)

17000 (BNWL-SA-1682) BIOLOGICAL EFFECTS OF HANFORD HEAT ON COLUMBIA RIVER FISHES: A REVIEW. Nakatani, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 15, 1968. Contract AT(45-1)-1830. 24p. Dep. CFSTI.

Four pairs of ripe salmon were taken from Priest Rapids spawning channel maintained by the Washington State Department of Fisheries. After fertilization, eggs were transported to a hatchery and distributed among seven troughs. A study was made on the temperature tolerance of young chinook salmon that spawned between October and December. Lots were subjected to seven temperature conditions differing by intervals of 2°F. The coldest of the test temperatures closely approximated the average river temperature at Priest Rapids Dam. For all lots, among the survivors a 2°F increment in temperature resulted in increasing the body weight by approximately a factor of 1.4. Fish in the warmest lots were as much as eight times heavier than those in the coldest lots at the end of the test. A study of sonic-tagged salmon and steelhead trout was carried out to determine behavior of adult fish near reactor plumes. The tag emits a high frequency signal that is tracked by biologists using hydrophones in a boat. The data showed no temperature block of fish, but most fish migrated upstream along the opposite bank from reactor sites. Periodic samples of fish captured near Hanford showed that the incidence of columnaris disease at Hanford was little different from fish sampled at sites upstream or downstream from the reservation. Studies on counts of columnaris organisms in the water showed an increase when the temperature rose above 50°F and a decline when the temperature decreased. The studies illustrate the significance of fish ladders in the etiology of the disease in the Columbia River. The best evidence of any significant effect of reactor heat on Columbia salmon is the continued viability of the fall chinook population that spawns within the Hanford Reservation. (H.L.W.)

17001 (CONF-680108-1) MILK TO AIR RATIOS FOR ^{131}I CONCENTRATIONS (PROJECT ROVER). Bernhardt, David E. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Jan. 1968. Contract SF-54-373. 31p. Dep. CFSTI.

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga.

Public Health Service environmental surveillance results from Project Rover reactor tests at NRDS (1962 to 1967), Jackass Flats, Nevada, were evaluated to determine the following parameters for predicting ^{131}I concentrations in milk: peak concentration in vegetation to integrated air concentration-pCi/kg : pCi-sec/m^3; peak concentration in milk to peak concentration on vegetation-pCi/l : pCi/kg; peak concentration in milk to integrated air concentration-pCi/l : pCi-sec/m^3. The parameters are described by a log normal distribution with geometric mean ($\bar{X}_g$) and geometric standard deviation (S_g). Thus both the most probable value and the variation of the value is described. The value obtained for milk to air was 4×10^{-4} pCi/l : pCi-sec/m^3 with an S_g of three. The use of a log normal distribution, in addition to being a reasonable fit of the data, allows a simple propagation of errors for the products of parameters. (auth)

17002 (UCRL-50347) CONCENTRATION FACTORS: THEIR USE AND ABUSE. Harrison, Florence L. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 7, 1967. Contract W-7405-eng-48. 5p. Dep. CFSTI.

The use of concentration factors as an index of an aquatic organism's ability to concentrate constituents in its environment is discussed. The values of concentration factors can vary considerably depending on the method of their measurement. A true concentration factor can be approximated by determining the ratio of the stable element concentration in a representative population to that of a representative water sample, or by determining the radionuclide concentration factor of a population in equilibrium with its biological exchangeable pool. Before concentration factors are used for the assessment of radioactive contamination of food chains, the method of measurement should be examined carefully to ascertain whether they are applicable to the situation under consideration. (auth)

17003 DISPERSION STUDIES OF CULEX PIPIENS FATIGANS TAGGED WITH ^{32}P IN THE KEMMENDINE AREA OF RANGOON, BURMA. Lindquist, A. W.; Ikeshoji, T.; Grab, B.; de Meillon, Botha; Khan, Z. H. (Smithsonian Institution, Washington, D. C.). Bull. World Health Organ., 36: 21-37(1967).

Methods are described for radioactive labeling of mosquitos used in field dispersion studies. Between 60,000 and 70,000 3rd and 4th stage larvae were placed in sheet-iron vats (30 × 24 × 5 in.), and tap water (17.4 l) was added to each of four vats, together with ground dog biscuits for larval food. Radiophosphoric acid (^{32}P) was added at a concentration of 0.05 µCi/ml of water. It was expected that ^{32}P at this concentration would be adequate to tag various species of mosquito larvae. Preliminary tests with C. pipens fatigans were made at this concentration as well as at 0.025 µCi/ml and 0.1 µCi/ml of water. The uptake of ^{32}P by the larvae depended on the length of time they were exposed in the water to the radioisotope, also by the number of larvae present, the amount of organic matter in the water, and the type of container used. Because the larvae were of different ages at the start, they showed a variation in the cpm values recorded on the scaler. However, the adult mosquitos emerging from the treated larvae were tagged sufficiently to give 400 to 1900 for females and 300 to 1300 cpm for males. After release and collection at various field sites, the mosquitos were killed and examined for radioactivity on a portable 5-decade battery-operated scaler. The scaling unit was a Type 1287 A unit (Dynatron Radio) and the G-M tube Type M X 108/01 with a window thickness of 1.5 to 2.5 mg/cm^2 located in a closed hardwood box. The radioactive tagging method described seemed to be harmless to the mosquitos and gave excellent results. Radioactive adults emerging under normal conditions from larvae collected in the center of the Kemmendine Experimental Area did not appear to differ in flight behavior from radioactive adults released at one time in the center. Mosquitos of both sexes dispersed evenly in all directions from the release point. The method yielded valuable data on the daily mortality of adults and on the total mosquito population in the area. (BBB)

Genetics and Cytogenetics

Refer also to abstracts 16974, 17050–17052, and 17054.

17004 (RLO-353-15) NATURE, INDUCTION, AND UTILIZATION OF MUTATIONS IN HIGHER PLANTS. Nilan, R. A. (Washington State Univ., Pullman. Dept. of Agronomy). May 5, 1967. Contract AT(45-1)-353. 22p. Dep. CFSTI.

Data are reviewed from a number of studies on the induction of mutations in barley (Hardeum vulgare) by exposure of seeds to γ to x radiation or to chemical mutagens. Mutations are analyzed, and agricultural utilization is discussed. It is pointed out that most induced mutations in higher plants are recessive and that, among the hundreds of mutations induced in barley, only a few are true dominants. Data are reviewed that indicate that the majority of mutations induced by γ or x radiation are associated with chromosome aberrations and that chemical mutagens, such as ethyl methanesulfonate (EMS), induce mutations that appear to involve a single locus. Attempts to increase the mutagenic efficiency of γ or x radiation have shown that pH and temperature alter the ratio of gene mutations to chromosome aberrations. It is concluded that the complete range of events that may constitute induced mutations in higher plants is still not completely understood. (68 references.) (C.H.)

17005 STUDIES ON THE EFFECTS OF IAA, TIBA, AND X-RAY IRRADIATION ON THE APPEARANCE OF ABNORMAL SPIKELETS IN A SPECIAL VARIETY OF PADDY RICE "AKAHO". Shimizu, Masaharu; Kuno, Katsuji (Nagoya Univ., Japan). Nippon Sakumotsu Gakkai Kiji, 35: 257-63(Dec. 1966). (In Japanese).

The effects of 3-indoleacetic acid (IAA), 2,3,5-triiodobenzoic acid (TIBA), and x radiation on the appearance of abnormal spikelets, and the changes in sex expression were investigated in a special Akaho variety of paddy rice. Akaho is known to have very unstable characters in regard to the morphogenic regulation of spikelet genetics and to express various abnormalities of spikelet under usual cultivating conditions. Since this experiment was carried out in the winter at temperatures of 25 to 30°C, the short-day condition promoted female and depressed male sex expression. With external application of IAA, the femaleness was promoted further and the maleness was suppressed, decreasing the number of stamens and increasing the organs of intermediate structure that were partially transformed stamens to pistil and the pistils of multi-ovary plants. The application of TIBA and x irradiation showed inhibitory effects on the shifting tendency of the control plants toward femaleness, increasing stamens and decreasing the pistils of multi-ovary plants in number, particularly in the plots exposed to x radiation. In these plots, the morphological abnormalities in glumes and the development of additional glumes appeared more frequently than in the control. From the results above mentioned, it was clear that an elevation of auxin level promotes the female and depresses the male sex expression in rice plants. Based upon the results obtained and other observations regarding the effects of gibberellin on the spikelet morphogenesis, it was concluded that the endogenous level of gibberellin-like substances may be high at the early stage of spikelet development and afterwards that of auxin-like substances may become dominant in the regions of organogenesis, and the unbalance of these substances in spikelet development induces various abnormalities in the spikelet morphogenesis. (auth) (NSA of Japan)

17006 EFFECT OF CELL CYCLE ON RECOVERY FROM RADIATION DAMAGE IN THE MOUSE LIVER. Coggle, J. E. (St. Bartholomew's Hospital, London). Nature (London), 217: 180-2(Jan. 13, 1968).

Chromosomal aberrations induced in mouse hepatocytes by single and fractionated doses of x rays given at various times before and after surgical hepatectomy are described. The data indicate that the different phases of the cell cycle may differ not only in their sensitivity to radiation chromosomal damage, but also in their ability to recover from such damage. There was a very large difference in radiation sensitivity, as far as chromosomal damage was concerned, between cells irradiated in the G_0 phase and the early S phase. In the latter case the curve obtained also showed a pronounced shoulder, indicative of repair of damage. There appeared to be no significant difference in chromosomal damage in G_0 cells as between single and split doses given before partial hepatectomy over the 24 hr period studied, but there did appear to be a recovery when split doses were given after partial hepatectomy. Reasons for the difference in sensitivity are obscure, but an oxygen effect could be involved since in regenerating liver there is an inflammatory reaction, and increased oxygenation possibly results in increased sensitivity. Increased sensitivity could also be a result of difference between irradiation time and damage assay time. It is suggested that the population feedback mechanism that keeps cells in G_0 may also inhibit the metabolic pathway necessary for repair of damage. (UK)

17007 PHYSIOLOGICAL REGENERATION OF CORNEAL AND DUODENAL EPITHELIUM FRACTIONALLY IRRADIATED WITH FISSION NEUTRONS. Mastryukova, V. M.; Strzhizhovskii, A. D. Kosm. Biol. Med., 1: 43-7(1967). (In Russian).

White mice weighing 18 to 20 g were irradiated with neutrons (86 rad-%) and gamma rays (14 rad-%) in an IRT-1000 reactor (dose rate, 32 rad/min; daily dose, 10, 25, and 100 rad/day). The mice were exposed daily (except Wednesdays and Sundays) for 7 weeks. A number of the irradiated and control mice were killed each week, and the corneal and duodenal epithelium was examined microscopically to determine mitotic index and incidence of chromosome aberrations. Comparison of the proportion of chromosome aberrations after single exposure and multidose (fractional) irradiation reveal the compensating capacity of genetic cell structures. One day after irradiation with 70 rad (average daily dose at the rate of 500 rad/week), the proportion of chromosome aberrations was 34% (i.e., 34% of all cells showed genetic damage). If damage were uncompensated and cumulative, a genetic damage incidence of 99% would be expected after 16 days of irradiation at this dose rate. The observed incidence of genetic damage was only 32%, showing that repeated irradiation either raises the resistance of genetic structures to radiation damage, or (less likely) increases the rate at which damaged cells are eliminated from tissue. The epithelial cells of the cornea and duodenum can thus compensate damage caused by fractional irradiation at a constant rate and establish an equilibrium state which depends on the dose rate but which is not affected by the constant total dose cumulation. This is not true of the organism as a whole, however, since endocrine and nervous tissue damaged at the same time regenerate very slowly and are much more subject to cumulative radiation damage. (ATD)

17008 GENETIC VARIABILITY IN OATS FROM RECURRENT AND ALTERNATE TREATMENT WITH PHYSICAL AND CHEMICAL MUTAGENS. Joshi, S. N. (Junagadh Agricultural Coll., India); Frey, K. J. Radiat. Bot., 7: 513-20(Dec. 1967).

Oat seeds of Clintland 60 variety were treated with thermal neutrons (TN), ethyl methanesulfonate (EMS) or nothing (controls) in 1960. M_4 populations derived from each of these treatments were sampled, and the seeds were treated again either with the same mutagen (recurrent treatment) or the other mutagen (alternate treatment); M_4 seed from 1960 TN treatment were treated with EMS, and vice versa, in 1964. M_2-derived oat lines from 1964 seed treatments were measured in a field-grown experiment for heading date, plant height and weight per 100 seeds. The effect of one treatment method vs. the other was compared through genetic variances. There were no significant genetic variances for traits in the control populations. Genetic variances from EMS treatment ranged from 125 percent for 100 seed weight to 35 percent for heading date larger than those from TN treatment. Two treatments with mutagens, either recurrent or alternate, produced significantly greater genetic variability than did one treatment for all traits. The alternate treatment sequence (i.e., TN–EMS and EMS–TN) produced 16 per cent more genetic variability than did recurrent treatment (TN–TN and EMS–EMS). The data suggest that loci that affect the expression of the three traits studied are somewhat mutagen specific. The significance to mutation breeding is explained. (auth) (UK)

17009 INDUCED VARIABILITY AND SELECTION ADVANCE FOR BRANCHING IN AUTOTETRAPLOIDS OF BRASSICA CAMPESTRIS VAR. TORIA. Gupta, A. K.; Swaminathan, M. S. (Indian Agricultural Research Inst., New Delhi). Radiat. Bot., 7: 521-7(Dec. 1967).

Toria (B. campestris var. toria) is an important oilseed crop in India, and autotetraploids ($2n = 4 \times = 40$) were produced in 1941 by colchicine treatment of the strain T.22. The seed fertility of the autoploid was initially very low, but was brought to the level of the diploid through a cycle of mass pedigree selection. In spite of the improved fertility and also larger seed size, the yield of the autoploid did not exceed that of the diploid, owing to a reduction in its ability to produce secondary and tertiary branches. Seeds of an "evolved" autoploid culture belonging to the C_{19} generation were exposed to 96 and 128 kR of x rays in 1960, and a biometrical study of progeny means and variances was conducted in the M_2 and M_3 generations. Selection norm for secondary branch number was fixed at a minimum of 20 per plant, and the selected plants were allowed to intercross. Recurrent selection was practised in the M_4, M_5, and M_6 generations. A yield trial, comparing the selected bulks from the treated and control families, was conducted at two locations during 1965–66. The results indicated that the variance for secondary branch number was enlarged in the M_2 and M_3 populations, while the means were not affected, that there was a positive selection advance for branch number during the M_3, M_4, and M_5 generations, and that true-breeding tetraploid cultures with a significantly higher number of secondary branches could be established. The poor branching ability of the autoploid population could thus be remedied, and promising tetraploid cultures developed. (auth) (UK)

17010 GENETIC NATURE OF SOMATIC MUTATIONS FOR FLOWER COLOR IN TRADESCANTIA, CLONE 02. Mericle, L. W.; Mericle, R. P. (Michigan State Univ., East Lansing). Radiat. Bot., 7: 449-64(Dec. 1967). (COO-1400-12).

The occurrence of "red" mutant sectors within the "blue" petals and stamen hairs of the hybrid Tradescantia (02 clone) is one of the most radiosensitive biological indicators known. Inbreeding experiments and sectoring within hairs indicate that the 02 clone is not chimeric, but overall heterozygous for flower color. Selfing the hybrid yields a typical Mendelian monofactor 3 : 1 ratio of blue to red-flowered progeny. Red flower color in recessive progeny is caused by primarily the anthocyanin aglycone, cyanidin; these progeny differ from the parental clone by their inability to synthesize delphinidin. Sectoring capability is transmissible germinally. The ratio of sectoring : non-sectoring blue-flowered plants confirms that heterozygosity is a prerequisite for sectoring. Inherent differences among progeny suggest that sectoring frequency is controlled by an unlinked modular system that through change in state (mutation) or dosage (segregation) yields the observed high and low sectoring classes. Sectors arising spontaneously, or induced by high or low acute or chronic radiation levels, differ in frequency, distribution within an organ, and association with micronuclei, indicating that different mechanisms are probably playing the predominant causal roles. Chromosome (or sub-unit) breakage accompanied by genetic deletion is the most probable mechanism for sector induction by relatively high radiation levels. Spontaneous sectors, or those caused by low chronic radiation appear to involve little or no chromosome fragmentation. Gene mutation, chromosome non-disjunction, and mitotic crossing-over are possible mechanisms—especially the latter because of similarities in behavior with age, environment, and radiation between sectoring in the 02 clone and presumed cross-over events in other organisms. Genetic control of sectoring frequency is postulated to operate through modulation of the degree of somatic association between homologous chromosomes. (auth) (UK)

17011 CROSSING-OVER IN THE MALES OF DROSOPHILA ANANASSAE: EXCHANGES IN IRRADIATED PUPAE. Kale, P. G. (Banaras Hindu Univ., Varanasi, India). Int. J. Radiat. Biol., 13: 1-12(1967).

Crossing-over in the males of D. ananassae was studied by treating early and mid-pupal stages with 1000 R and 2000 R of x rays. Spermatocytes produce single cross-overs distributed evenly between males. Spermatogonia produce clusters of cross-overs, the progeny of particular males. A twofold increase in the frequency of cross-overs from independent events by doubling the dose indicated the breakage of two chromatids by a single ionizing particle. The frequency of these exchanges in early pupae is much greater than of those in later stages of the life-cycle. This was attributed to the predominant proportion of the spermatocytes in the young pupae. Alternatively these early spermatocytes may be intrinsically more sensitive. (auth)

17012 RELATIONSHIP BETWEEN CHIMERAS AND MUTATIONS INDUCED BY ^{60}Co γ-RAYS AND 2 MeV FAST NEUTRONS AT SPECIFIC LOCI IN BREAD WHEATS. Rana, R. S.; Swaminathan, M. S. (Indian Agricultural Research Inst., New Delhi). Radiat. Bot., 7: 543-8(Dec. 1967).

The comparative biological effects of ^{60}Co γ-rays and 2 MeV fast neutrons were studied using dormant seeds of the three bread wheats, Triticum aestivum ssp. vulgare, compactum and sphaerococcum. Doses were chosen on the basis of comparable growth inhibition and lethality. Germination count, seedling growth rate, survival at maturity, chromosome aberrations, pollen and seed fertility, M_1 chimeras and M_2 mutations at specific loci, and frequencies of chlorophyll mutations in the M_2 population were used as indices of radiosensitivity. The data consistently revealed that the frequency of induced mutations was nearly 20 times higher after fast neutron irradiation than after gamma treatment. Hemizygous or heterozygous condition at the Q, C, and S loci has a characteristic phenotypic consequence in vulgare, compactum, and sphaerococcum, respectively, and, chimeras can be readily detected in the M_1 if mutations or deletions occur at these loci. The efficiency of mutagens in inducing viable mutations in the M_2 generation can be reliably predicted in this material from the frequency of chimeras in the M_1. The availability of specific loci with a visible phenotypic effect in the hemizygous or heterozygous condition renders bread wheat ideal for such studies. (auth) (UK)

17013 ANTHOCYANIN PIGMENTS IN MUTANT AND NON-MUTANT COLEUS PLANTS. Love, J. E.; Malone, B. B. (Univ. of Tennessee, Oak Ridge). Radiat. Bot., 7: 549-52(Dec. 1967).

A comparative study was made of the anthocyanin pigments in control, mutant (radiation-induced), and back-mutant Coleus plants. Pigment identification was accomplished by using Rf values and absorption spectra following separation with paper chromatography. Only one anthocyanin, cyanidin-3-monoglucoside, was extracted from all plant types. The amount of this pigment, however, varied with plant type. It would appear, therefore, that color differences between control, mutant, and back-mutant plants were caused by a variation in the amount of one anthocyanin pigment rather than a change in structure of the pigment molecule itself. (auth) (UK)

17014 STUDIES OF THE GENETIC NATURE OF RADIATION EFFECTS IN THE SILKWORM. Akhalaya, Ya. G. Soobshch. Akad. Nauk Gruz. SSR, 58: 453-4(Nov. 1967). (In Russian).

Changes observed in the mutation rates in the silkworm exposed to ionizing x irradiation during various stages of gametogenesis were analyzed. The analysis of the two generations produced by x-irradiated parents confirmed the genetic nature of radiation effects in the silkworm. (R.V.J.)

17015 THE PROPERTIES OF UV SENSITIVE MUTANTS OF ESCHERICHIA COLI K12 THAT ARE ALSO REFRACTORY TO COLICIN E2. Holland, I. B. (Univ. of Leicester, Eng.). Mol. Gen. Genet., 100: 242-51(1967).

Among mutants refractory to colicin E2 at low temperatures but sensitive at high temperatures, three strains are described that are also uv sensitive. Although colicin refractivity is temperature dependent uv sensitivity is expressed at all temperatures. Although the uv sensitive lesion appears to be similar in its effects to that in Rec (recombinationless) strains, mutants specifically isolated as Rec strains are in fact more sensitive to E2 than are wild type strains. It is suggested that E2 refractivity and uv sensitivity in the mutants probably reflects the phenotypic expression of distinct although linked genes. It is also suggested that the degradation of DNA stimulated by adsorption of E2 to wild type bacteria may be caused by the same enzyme(s) that causes enhanced breakdown of DNA in some rec^{-} mutants after uv irradiation. (auth)

17016 MUTATIONAL AND DARK-REPAIR SPECIFICITIES IN U.V.-IRRADIATED DI-AUXOTROPHS OF E. COLI B/r. Clarke, C. H. (Univ. of Edinburgh). Mol. Gen. Genet., 100: 225-41(1967).

Ultraviolet irradiation experiments were performed with three tyr^{-}leu^{-} diauxotrophs of E. coli B/r; 36–10, 36–18, and 36–32. These have in common the tyr^{-} marker WU-36. Three types of mutations were scored; tyr^{+}leu^{-}, tyr^{-}leu^{+}, and tyr^{+}leu^{+}. The percentages of total mutants scored that are of the tyr^{+}leu^{+} type depend, firstly, on the strain. The tyr^{+}leu^{+} revertants are rare in 36–10 and common in 36–18 and 36–32. Secondly, the percentages of tyr^{+}leu^{+} among total revertants are determined by the nature of the plating medium, being altered by supplementation with a low level of the required amino acids, a low level of nutrient broth, or by caffeine. These differential effects upon tyr^{+}leu^{+} and tyr^{+}leu^{-} or tyr^{-}leu^{+} reversions can be interpreted at the levels of dark-repair and the later stages in the process leading to phenotypic expression. It is suggested that states of repression and derepression may be implicated in determining susceptibility of lesions in suppressor loci to repair processes. Phenotypically different classes of mutations have different pathways leading to final expression. (auth)

17017 RATES OF AUTOSOMAL RECESSIVE LETHALS AFTER X-RAY TREATMENT OF SPERMATOGONIA AND SPERMATOZOA IN DROSOPHILA MELANOGASTER. Ytterborn, Karl H. (Univ. of Stockholm). Hereditas, 58: No. 1-2, 165-90 (1967).

Adult males were irradiated and immediately afterwards mated for four hours in order to test the incidence of second chromosome recessive lethals in spermatozoa. To test the effects of irradiation on spermatogonia seventeen-hour-old larvae were irradiated. After eclosion males were mated in six consecutive periods. Male progeny from two of these matings, 0 to 3 days and 15 to 18 days respectively after eclosion, were sampled for tests of lethals. The dose used was 900 R x rays. By comparisons with different histological and genetical investigations it was assumed that the tests of seventeen-hour-old larvae contain predefinitive and definitive spermatogonia and that treated spermatogonia of both types have contributed spermatozoa to the mating period 0 to 3 days after eclosion while only treated spermatogonia of the predefinitive type contributed spermatozoa to the period 15 to 18 days. The total mutational damage when measured as frequencies of chromosomes with lethals is similar in the two tests from irradiated spermatogonia. The incidence of independent lethal mutations, however, is higher in the period 0 to 3 days than in the period 15 to 18 days while the average cluster size is larger in the last period than in the first. The distributions of independent lethal mutations among males in the two spermatogonia series do not deviate from Poisson expectations. The spermatogonia of different males therefore seem to be equally sensitive. The frequency of chromosomes with lethals was found to be about three to four times higher after irradiation of spermatozoa than after the same treatment of spermatogonia. (auth)

17018 MUTAGENIC SPECIFICITY AT THE AD-8 LOCUS IN NEUROSPORA CRASSA. Ishikawa, Tatsuo (Tokyo Univ.). Nippon Idengaku Zasshi, 42: 43-50(Feb. 1967).

Analysis of adenine-8 (ad-8) alleles in N. crassa isolated after treatment with various mutagens indicated that spontaneous and uv-induced mutations may recur at certain sites (hot spots) and that spontaneous and x-ray-induced mutations may result in larger defects in the genetic material. The ad-8 mutants were obtained spontaneously or after treatment with following mutagens: uv and x rays, nitrous acid, ethylmethanesulfonate (EMS), 5-bromodeoxyuridine (BUDR), and/or 5-fluorodeoxyuridine (FUDR). A genetic fine structure map was prepared that indicates the relation between the distribution and origin of mutants. (BBB) (TSS)

17019 STUDY OF 1000 CARYOTYPES IN NON-IRRADIATED SUBJECTS. Mouriquand, C.; Gilly, C.; Patet, J.; Jalbert, P. (Faculte de Medecine, Grenoble, France. Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend. Soc. Biol., 161: 341-7(1967). (In French).

A study was made to establish a chromosome balance in a "normal" population, that could be used as reference for observations made in circumstances where there is a suspicion of contact with ionizing radiations. The study was made on 43 children hospitalized or seen in consultation for congenital malformations. Forty-seven adults, parents of these children or laboratory workers, were also examined. The number and morphology of the chromosomes were analyzed statistically. The differences were determined as a function of age and sex, and the frequency and type of variation were evaluated. The results are tabulated and show the existence of an aneuploidy that seems to be due to technique. The differences between male and female could not be explained. The study showed structural anomalies. The results showed the rarity of chromosomic breaks and the absence of chromatid exchanges and especially of chromosome modifications, noted so frequently after irradiation. (J.S.R.)

17020 EKSPERIMENTAL'NYE RABOTY PO VLIYANIYU IONIZIRUYUSHCHIKH IZLUCHENII NA ORGANIZM. (Experimental Data on the Ionizing Radiation Effects on Organism). Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. 271p.

Separate abstracts were prepared for 16 chapters of the book. Various aspects of genetic and somatic effects of ionizing radiation on plants and animals were investigated and results are presented. (H.L.W.)

For abstracts of individual chapters see: 16979, 17021, 17022, 17036–17044, and 17051–17054.

17021 DIFFERENCES IN RADIOSENSITIVITY OF CHROMOSOME APPARATUS IN DIFFERENT MOUSE STRAINS. Domareva, O. P.; Dmitrieva, T. I. pp 137–42 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

Data on the radiosensitivity of the chromosomal apparatus of somatic cells in three mouse strains having different general radiosensitivities are presented. It was shown that the percentage of chromosomal aberrations in the corneal epithelium, both on the second and the sixth day after irradiation, was higher in BALB/c than in C$_3$H and CC$_{57}$Br. The influence of strains, i.e., the hereditary factor, is revealed in the recovery period to a greater extent than during the primary damage to the chromosome complex. The radiosensitivity of the chromosome apparatus of different strains corresponded to their general radiosensitivity. (auth)

17022 INFLUENCE OF DIFFERENT RADIATION DOSE RATES ON THE FREQUENCY OF DOMINANT LETHALS IN MATURE SEX MAMMALIAN CELLS. Nizhnik, G. V. pp 143–57 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

The frequency of dominant lethals in rabbit spermatozoa depending on different dose rates of ^{60}Co radiation was studied. It was established that the incidence of dominant lethals in spermatozoa exposed to a dose of 800 R and a dose rate of 365 R/min differs statistically from that observed in spermatozoa irradiated at a dose rate of 11.7 R/min (84.5 ± 2.4 and 67.6 ± 2.4%). The exposure of spermatozoa to other dose rates (1020 R/min and 9 R/min) did not reveal any differences in the incidence of dominant lethals (70.7 ± 5.0 and 69.2 ± 4.0%). (auth)

Health Physics and Safety

Refer also to abstracts 16737, 16998, 17001, 17050, and 17067.

17023 (BNWL–542) THE ESTABLISHMENT AND UTILIZATION OF FILM DOSIMETER PERFORMANCE CRITERIA. Unruh, C. M.; Larson, H. V.; Beetle, T. M.; Keene, A. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1967. Contract AT(45-1)–1830. 209p. Dep. CFSTI.

The need for the establishment of a central calibration laboratory for processors of film dosimeters is discussed. It is pointed out that in 1967 at least 15 commercial firms in the United States offered film dosimeter processing and evaluation service, while an even greater number of AEC prime contractors and military installations operated their own film dosimeter services. Criteria for acceptable levels of performance are discussed. An evaluation of the performance level of film dosimeter processing demonstrated a wide spectrum of performance levels. It was concluded that a program that would provide an assessment of the quality of film processing services is very desirable. It is recommended that evaluation programs may be enhanced by the establishment of a central calibration laboratory. Cost estimates for a calibration laboratory are included. (C.H.)

17024 RADIATION MAGNITUDES AND UNITS. Bruynesteyn, W. (Fysisch Laboratorium Rijsuniversiteit, Utrecht). Ned. Tijdschr. Natuurk., 33: 134-54(Apr.-May 1967). (In Dutch).

The radiation magnitudes and units of the various branches of study (interaction between radiation and matter, reactor physics, radiology, radiobiology, photometry, and acoustics) are defined and compared with each other. (J.S.R.)

17025 INTERNATIONAL REGULATIONS FOR TRANSPORT OF RADIONUCLIDES. Nucl. Eng., 13: 31-8(Jan. 1968).

The development and present status of the IAEA regulations are summarised. The extent of adoption by international bodies that control transport by road, rail, sea, inland waterways, and air is discussed. The insurance and indemnity requirements that were laid down in three conventions are considered, and progress towards ratification is reported. An analysis is presented of 171 transport accidents and incidents that occurred between 1948 and 1965. (UK)

17026 ACTIVE MATERIAL TRANSPORT. Hagsgard, S.; Hedland, R. (Aktiebolaget Atomenergi, Stockholm). Nucl. Eng., 13: 40-2(Jan. 1968).

The problem of transporting large amounts of radioactive materials, both nuclear fuel and other sources, is discussed. On the basis of existing regulations transport facilities have been developed, constructed and tested, partly in collaboration with IAEA. A considerable number of transportations were affected to a point of near routine. The experience is described, and some transport costs and statistics are given. (auth) (UK)

17027 RADIATION SITUATION NEAR THE BELOYARSK NUCLEAR POWER STATION. Petros'yants, A. M. At. Energ. (USSR), 23: 38-41(July 1967). (In Russian).

Data are given on the concentration of radioactive aerosols, density of radioactive fallout, content of radioactive substances in water and other exposed areas in the vicinity of the Beloyarsk atomic power plant during 1963 to 1966. The studies did not reveal any increase in the natural radioactivity level of the region. (tr-auth)

Medicine

Refer also to abstracts 16632, 16636, 16638, 16779, 16984, and 17050.

17028 ENDOTOXIN PROTECTION AND COLONY-FORMING UNITS. Hanks, G. E.; Ainsworth, E. J. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 32: 367-82(1967).

Bacterial endotoxin is known to increase survival of irradiated animals and to be a potent stimulator of the hematopoietic system. The purpose of the present experiment was to study the effect of endotoxin on hematopoietic stem cells, as evaluated by colony-forming units (CFU's), and to determine the extent to which changes in the numbers of CFU's could be correlated with the survival-promoting effects of endotoxin. The greatest effects on survival and CFU content of the spleen occurred when endotoxin was given 24 hours before x irradiation. Animals treated in this manner showed at least a 25-fold increase in spleen CFU's, but no alteration in the CFU D$_{37}$ of about 90 R. In general, the largest increases in spleen CFU's were produced by procedures (dose, route, number of times of injection) that produced the greatest survival. On the other hand, by varying the time of endotoxin injection relative to irradiation, it was shown that the numbers of spleen CFU's were increased under circumstances where survival was not increased. Therefore, no consistent correlation between spleen CFU's and survival was observed. Speculation is offered concerning factors that my influence the numbers of spleen CFU's in endotoxin-treated mice and concerning stem cells, CFU's, and radiation sensitivity. (auth)

17029 EFFECTS OF CHEMICAL PROTECTION ON REPAIR OF POTENTIALLY LETHAL IRRADIATION INJURY IN RHIZOPUS STOLONIFER SPORANGIOSPORES. Buckley, Patricia; Sommer, N. F.; Gortz, J. H.; Maxie, E. C. (Univ. of California, Davis). Contract AT(11-1)-34. Radiat. Res., 30: 275-82 (Feb. 1967). (UCD-34P73-13).

Rhizopus stolonifer sporangiospores γ irradiated anoxically in suspensions containing cysteamine (MEA) showed a nearly twofold increase in survival of spores when plated without a 48-hour recovery period. After a 48-hour delay, however, equal numbers of survivors were found whether spores had been MEA-protected or not. When spores were irradiated in suspensions in contact with air and plated immediately thereafter, MEA caused a twofold increase in the number of survivors. However, MEA protection during irradiation and subsequent recovery was partially additive. That is, more surviving colony formers were found after the 48-hour recovery period among spores that had been MEA-protected than among those that had not. Spores produced from cultures grown on water agar were slightly less resistant to γ radiation than were spores from a nutritionally richer medium. Despite the poor growth conditions, water agar-grown spores showed considerable ability to recover from radiation injuries, although this was far less than that of spores nutritionally more fortunate. (auth)

17030 SELECTIVE DESTRUCTION OF CANCER CELLS. Hart, Roger G. (Lawrence Radiation Lab., Livermore, Calif.). Perspect. Biol. Med., 10: 592-600(Summer 1967).

Fundamental aspects of the combined use of radiation and chemotherapy to destroy cancer cells were examined. It was proposed that cancers could be cured by a combination of a treatment that reversibly suppressed mitosis of normal cells, but not of cancer cells, and a treatment that killed dividing cells. In such a strategy, the latter killed cells entirely on the basis of their phase, while the former provided the necessary discrimination between normal and cancer cells by allowing only cancer cells to reach the phase vulnerable to the latter. The combination of treatments might achieve a highly selective destruction of cancer cells without needing drugs of marked specificity. Tritium-labeled thymidine was considered as a candidate for the latter. The advantage of tritium over other possible radioactive labels was the extreme softness of its β emission (0.018 MeV). Nearly all of the energy of such a particle would be released in the cell nucleus where it originated. Thus, if only cancer cells were permitted to synthesize DNA in the presence of tritium-labeled thymidine, only cancer cells would be labeled and destroyed by it. However, if labeled cells continued to die and disintegrate after the former protection was gone, tritium-labeled material would become available for reutilization by normal cells. This hazard could probably be minimized by the continued administration of an appropriate cold chaser containing nonradioactive chemical competitors. A combination treatment for the latter was also considered. For example, incorporation of 5-iododeoxyuridine into DNA of mammalian cells made them more sensitive to x rays. If cell sensitivity to internal β emissions was also increased by this compound, a highly efficient agent for the latter treatment might consist either of the simultaneous administration of tritium-labeled thymidine and 5-iododeoxyuridine or tritium-labeled 5-iododeoxyuridine alone. (BBB)

17031 SYNERGETIC ACTION OF X RAYS AND OF THE ETHYLHYDRAZIDE OF PODOPHYLLIC ACID ON A SOLID ISOLOGOUS TUMOR OF THE C3H MOUSE. Donner, M.; Oth, D.; du Cluzel, O.; Burg, C. (Faculte de Medecine, Nancy). Compt. Rend. Soc. Biol., 161: 403-7(1967). (In French).

Female mice with CBl tumor were exposed to a single dose of x rays at 1500 rads. Ethylhydrazide of podophyllic acid (SPI) was injected in a single dose before the irradiation at time intervals from 0 to 24 hrs. The results showed that SPI has no effect on the tumor. When the SPI administration is followed within six hr by x radiation, there is a very significant increase of the effect of the x radiation. (J.S.R.)

17032 SYNERGETIC EFFECTS OF SOME SUBSTANCES WITH A RADIOPROTECTIVE ACTIVITY. Cier, A.; Maigrot, J. C.; Nofre, C. (Faculte de Medecine et Pharmacie, Lyon). Compt. Rend. Soc. Biol., 161: 360-3(1967). (In French).

The additive effects of anions and cations with the radioprotectors AET and serotonine were studied on white mice exposed to 350 and 750 rads and injected with the drugs before irradiation. The cations Ni, Zn, and Co in association at equitoxic doses with AET and serotonine gave an additive toxicity. No synergetic effects were observed; on the contrary the radioprotective effect of the organic compounds is decreased or even eliminated. The combination of AET and sertonine with sulfide, thiosulfate, and hypophosphite anions showed an unchanged or slightly reduced toxicity. The radioprotective action is increased significantly. (J.S.R.)

17033 TECHNETIUM, ^{99m}Tc. Pizon, P. Presse Med., 75: 477-9(Feb. 25, 1967). (In French).

The physical and biological properties of ^{99m}Tc are reviewed, and its uses as a radiodiagnostic agent, resulting in reducing patient radiation exposure and increased clinical information, as compared with some other isotopes, such as radioiodine, are surveyed. Its superior radiodiagnostic properties stem from the fact that it has a short half life (~6 hr) and emits only a γ photon (140 keV). Radiotechnetium, as pertechnetate, is rapidly eliminated from the body, so that the hazard to patients and personnel is minimal. Generation of ^{99m}Tc from ^{99m}Mo and its chemistry in labeling procedures are explained. In the use of ^{99m}Tc to examine the liver by scintigraphy a dose of 3 mCi gives a liver exposure of only ~1 rad, whereas 200 μCi of ^{198}Au would give about 10 rad to the liver. A 1-mCi intravenous dose causes a whole-body dose of only ~10 mrad. After 1 hr, 50 to 75% is excreted by the kidney. In the use of macroaggregated albumin for lung scanning the ^{99m}Tc-labeled preparation gives a pulmonary dose of only a few millirad for 5 mCi, compared with several hundred millirad with 300 μCi of ^{131}I-labeled albumin. Various other techniques employing the isotope are outlined. (BBB)

17034 POST-RADIATION OSTEOPATHY. Salib, Philip I. (Massachusetts General Hospital, Boston). Amer. J. Orthop., 6: 122-5(May 1964).

Effects of radiation on bone and the occurrence and treatment of radioinjury of bone are discussed with reference to several examples of osseous sequelae of radiotherapy. Postirradiation effects depend upon the type, dose, and frequency of irradiation, age of the patient, part and extent of the body exposed, and time elapsed since exposure. Five postirradiation osseous complications are described: retardation of bone growth, necrosis of bone, osteomyelitis, stress fractures, and radioinduced sarcomas. Children subjected to >2000 R are likely to show growth disturbances in bone. Necrosis of bone may occur years after exposure, with an average of 15 yr. Osteomyelitis may occur, particularly in the jaw, with massive sequestration and chronic fistulae, together with little tendency to involucrum formation. Infection is attributed to the buccal bacterial flora and root infection, associated with repeated minor mechanical factors or surgical intervention. The teeth may show a pinkish hue due to reduction of their density. Because of varying degrees of bone damage and consequent alteration in its physiology and strength, stress fractures may occur. Osteocytic necrosis and osteoporosis are the initiating factors that predispose to their occurrence. Following irradiation, symptoms may appear from 3 months to 30 yr, with an average of 3 yr. Postirradiation sarcomas usually occur around the hip or knee, and are more common after internal irradiation. (BBB)

Radiation Effects on Animals

Refer also to abstracts 16632, 16973, 16979, 16981, 16991, 16993, 16994, 16997, 16998, 17007, 17011, 17017, 17019–17022, 17032, 17050, and 17070.

17035 (NP-17232) EFFECTS OF HUMAN EXPOSURE TO IONIZING RADIATION. A Bibliography. Nevill, Ann D.; Jacobson, A. P.; McDermott, K. A. (Michigan Univ., Ann Arbor. School of Public Health). Mar. 1968. 70p. Dep. CFSTI.

A bibliography on the unplanned effects of radiation on humans is presented. It includes the years 1896 to mid-1967 and includes about 900 references, 250 of which are on Hiroshima and Nagasaki. (W.H.K.)

17036 GONAD DAMAGE IN FEMALE MICE DEVELOPING FROM IRRADIATED EMBRYOS. Nuzhdin, N. N.; Kuznetsova, N. N. pp 129-36 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

A study was made of the radiosensitivity of the ovaries of mice irradiated during embryonic development. It was established that the ovaries of embryos were more radioresistant than ovaries of mature mice and testes of embryos. Following exposure of embryos to 20, 100, and 200 R, damage to the ovaries was observed in one- and three-month old mice. In six-month old mice radiation effects were observed only with doses of 100 R or higher. A cumulative effect was observed with fractionated irradiation. (H.L.W.)

17037 CHANGES IN RADIOSENSITIVITY OF DIFFERENT STRAINS OF MICE IN MATURE AGE. Nechaev, I. A. pp 158-68 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

A study was made of the general radiosensitivity of male mice (strains BALB/c, $CC_{57}Br$ and $C_{57}Bl$) at the age of 4.5 and 7.5 months. Mice of this age are more radioresistant (as estimated from $LD_{50/30}$) than one-day to two month-olds. The main cause of death is damage to the haematopoietic system. The high sensitivity of the gastrointestinal system, typical of 30- to 60-day-old animals is followed by relative radioresistance. The calculations show the independent effects of the genotypical (strain) and phenotypical (age) factors on the level of radiosensitivity. The share of the first, explained as a result of selection, is estimated at 20%, and the second, typical of the species as a whole, at 68%. (auth)

17038 PERSISTENCE OF RADIATION DAMAGE TO CHROMOSOMES OF MALE GERM CELLS IN EMBRYO FIBROBLAST CULTURES. Chudinovskaya, G. A.; Kitaeva, O. N. pp 169-78 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

A cytological investigation of cultures of mouse embryo fibroblasts was conducted, using embryos obtained from crossing nonirradiated females to males exposed to x radiation at a dose of 400 R and to fast neutrons at a dose of 100 Rad. It was shown that during the irradiation of spermatozoa and spermatids a statistically significant increase in the number of cells with chromosomal aberrations (bridges and fragments) occurred. The preliminary administration of protective agents (mexamine and AET) to males before exposure did not lead to a diminished number of cells with chromosomal aberrations, as compared with the irradiated controls. (auth)

17039 GENETIC RADIOSENSITIVITY OF TWO STRAINS OF MICE. Nuzhdin, N. I.; Kitaeva, O. N.; Chudinovskaya, G. A. pp 179-87 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

A comparative study was made of the radiosensitivity of male germ cells (spermatozoa and spermatids) in two mouse strains ($CC_{57}Br$ and BALB/c) with contrasting general radiosensitivity. The incidence of dominant lethal mutations and the incidence of chromosomal aberrations in embryo liver tissue following whole-body single x irradiation of males at a dose of 400 R served as indexes of the radiosensitivity of germ cells. As a result of the investigations conducted, it was established that the radiosensitivity of male germ cells differs from their general radiosensitivity. (auth)

17040 EFFECT OF β-MERCAPTOETHYLAMINE ON GENETICAL EFFECTIVENESS OF HIGH-ENERGY PROTONS IN SO-

MATIC MAMMALIAN CELLS. Kurnishkov, I. S. pp 188-219 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

Mature male mice were given a single whole-body dose of 660 MeV protons and a dose of 300 R ^{60}Co γ rays. Mutations were induced in chromosomes of 28% of liver cells. The incidence of liver cells containing chromosome aberrations was reduced by pretreatment with β mercaptoethylamine. Protons were less effective than γ rays in inducing chromosome mutations in liver of mice. (auth) (TSS)

17041 SOME PECULIARITIES OF RADIATION RESPONSE AND RADIOPROTECTIVE ACTION OF CYSTEAMINE IN MICE OF DIFFERENT STRAINS. Graevskaya, B. M.; Nechaev, I. A.; Erokhina, L. V. pp 220-6 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

Effects of radiation of equivalent doses on the weights of liver and spleen and proteolysis in the blood of mice of different radiosensitivities were studied. Cysteamine was more effective in reducing radiation damage in mice of the strain CC$_{57}$Br than in those of the more radiosensitive strain BALB/c. (auth) (TSS)

17042 GENERAL AND CYTOGENETICAL RADIOSENSITIVITY OF MICE AS MODIFIED BY HORMONE ACTION. Kurnishkov, I. S. pp 227-40 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

Diethylstilbestrol, administered to mature male mice eight days before irradiation with ^{60}Co gamma rays, while reducing statistically animal mortality rate and diminishing changes in liver weight following exposure, does not have a substantial effect on the incidence of liver cells with chromosomal aberrations. The protective action of the given oestrogen in irradiated animals may consist in activating natural protection barriers or in altering the organism's immunological reactions without any appreciable effect on systems responsible for damage to cell chromosome apparatus. (auth)

17043 PROTECTIVE EFFECTIVENESS OF CARBON MONOXIDE IN RADIATION-INDUCED FORMATION OF CHROMOSOMAL ABERRATIONS IN SOMATIC MAMMALIAN CELLS. Nuzhdin, N. I.; Kurnishkov, I. S. pp 241-54 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

The irradiation of mature male mice with x rays at a dose of 300 R and a dose rate of 66.5 R/min in an atmosphere with 0.5% carbon monoxide is cytogenetically less effective than in normal air conditions. The decrease in the frequency of mouse liver cells with chromosomal aberrations in protected animals in a 30 day interval is statistically significant. The protection coefficient is 0.38. The protective effectiveness of carbon monoxide on liver cells is apparently caused by the fact that this compound by blocking the entry of oxygen into the tissue under study finally reduces the number of chromosome breaks and contributes to a quicker restitution of the fragments formed. (auth)

17044 EFFECT OF FAST NEUTRONS AND X-RAYS ON MITOTIC ACTIVITY OF CORNEAL EPITHELIUM. Domareva, O. P. pp 255-60 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

Effects of various doses of fast neutrons and x rays on the mitotic activity of corneal epithelium were studied. A linear dose dependence of mitotic activity on the dose of radiation was established. The estimated relative biological effectiveness was 12.7. It was shown that exposures to neutrons and x rays in equivalent doses resulted in different decreases in the number of epithelial cells. (H.L.W.)

17045 STUDIES ON THE ACTION OF NATURAL IONIZING RADIATION IN DROSOPHILA MELANOGASTER. Planel, H.; Soleilhavoup, J. P.; Giess, M. C.; Tixador, R. (Faculte de Medecine, Toulouse). Compt. Rend. Soc. Biol., 161: 467-70 (1967). (In French).

Previous studies have shown that natural ionizing radiations have a beneficial effect on unicellular animals by accelerating multiplication. Tests were made on Drosophila to determine if a similar effect could be observed on multicellular animals. The use of a radioprotective chamber caused a delay in the development of laying eggs. (J.S.R.)

17046 RADIATION EFFECT ON GROWTH OF THE CHICKEN X IRRADIATED DURING EMBRYONIC DEVELOPMENT. Tyler, Sylvanus A.; Stearner, S. Phyllis; Muller, Harry D. (Argonne National Lab., Ill.). Growth, 31: 105-17(1967).

Growth in the chicken was depressed by exposure to x rays during embryonic development. The deficiency rate at 45 days of age was ~23 g/100 R of the delivered dose. The Gompertz function was used to describe growth at ages less than 170 days. An approximately linear increase in weight between 170 and 800 days of age, which was characteristic of unirradiated birds, was generally absent among survivors of an acutely lethal irradiation. Sex differences due to radiation were slight. The radiation effect on weight was similar to that previously observed among young chicks irradiated at 3 to 4 days of age; however, the irradiated embryo seemed to possess a more efficient and/or faster responding mechanism for the repair of radiation damage than exists in the irradiated 3- to 4-day-old chick. (BBB)

17047 EFFECT OF VISIBLE LIGHT AND ULTRAVIOLET RAYS ON THE STIMULUS THRESHOLD OF FROG MUSCLE SENSITIZED BY EOSIN. Lakatos, T. (Medical Univ., Pecs, Hungary); Kollar-Morocz, A. Acta Biochim. Biophys. (Budapest), 2: 191-8(1967).

In experiments on muscles in situ, eosin (Na tetrabromofluorescein) was introduced into the muscle by perfusion in Ringer's solution containing eosin at a low concentration. Measurements were carried out on the voltage of the stimulus threshold which was plotted against time, immediately before irradiation and at the end of the second minute of the irradiation, both during perfusion with normal Ringer solution and in the presence of eosin. The alteration taking place during irradiation was calculated in each case. A decreased stimulus threshold was found during illumination with visible light. When the effect of uv irradiation was investigated, the stimulus threshold diminished in the presence of eosin. In experiments performed with isolated muscles the results were similar, but the voltages of stimulus threshold were lower. As in experiments carried out with muscles in situ, the diminution of the stimulus threshold of muscles containing eosin was about 10% during irradiation. Thus the stimulus threshold of frog gastrocnemius muscle decreased under the simultaneous action of eosin and light. Evidently, both visible light and the uv radiation transmitted their energy to the easily excitable fluorescent dye having an excited state with a long lifetime. In this way the energy could migrate to the irritable structure of muscle and excite the electron system of the sensitive structures. (BBB)

17048 SURGERY VERSUS RADIOACTIVE IODINE FOR HYPERTHYROIDISM. Block, Melvin A. (Henry Ford Hospital, Detroit). Surg. Gynecol. Obstet., 125: 1083-4(Nov. 1967).

Complications of ^{131}I treatment are considered in view of surgery as an alternative. Radioiodine therapy of hyperthyroidism resulted in a high incidence of delayed hypothyroidism and a prolonged time is required to achieve the euthyroid state. After adequate radioiodine therapy for hyperthyroidism, the incidence of hypothyroidism exceeds 40% after ten years. Since the onset of hypothyroidism after radioiodine therapy, it may be delayed until advanced age, and since the condition may not be obvious to the patient, these patients require indefinite follow-up evaluation. However, the simplicity of administration of radioiodine is an advantage over surgery. There are three reports of children showing evidence of carcinoma of the thyroid from 2 to 8 yr after radioiodine treatment for hyperthyroidism. Surgery is the preferred treatment for patients with toxic nodular goiter. The low uptake of radioiodine makes treatment with it more difficult and frequently inadequate. Radioiodine alone is preferred only for patients with mild toxicity from multinodular autonomous goiter with no cardiac complications requiring prompt control of the disease, and who are not good surgical risks. (BBB)

17049 AKTIVATSIONNYI ANALIZ BIOLOGICHESKIKH OB'EKTOV. (Activation Analysis of Biological Objects). Kist, A. A. (ed.). Tashkent, Izdatel'stvo Fan Uzbekskoi SSR, 1967. 163p.

Twenty-six articles are included on the neutron activation method for determining trace elements in animals, plants, and soils. Determinations of elements present in the blood and of the iodine content of the thyroid gland were made by fast neutron activation analysis and results are presented. Data are included on the content of As, Au, Cu, Mg, and Sb in soils. The content of zinc in the blood and urine was also determined by neutron activation analysis. Determinations were made on the chlorine content of the kidney tissue and on the mineral (Cl, Co, Mo, Na, and P) content of animal tissues during irradiation, and results are presented. A brief review is given of the uses of radioactivation analysis in biological and medical studies. A list of 423 references is included. (H.L.W.)

Radiation Effects on Plants

Refer also to abstracts 16779, 16973, 16980, 16997, 17004, 17005, 17008–17010, 17012, 17013, 17018, 17020, and 17029.

17050 (EUR-3606.e) APPLICATION OF ATOMIC ENERGY IN AGRICULTURE. Annual Report, 1966. (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen (Netherlands)). Aug. 1967. 92p. Dep.

The research activities of the EURATOM-ITAL Association were directed in 1966 to the application of atomic energy to agriculture. In addition to classical plant breeding experiments, studies were undertaken to investigate the improvement of mutagenic efficiency and the analysis of radiation effects, as well as to assess the possibilities offered by irradiation for food preservation. Related physical problems were also investigated. The behavior of specific nuclides in plants and soils, as well as the development and improvement of nuclear techniques for agricultural research. (auth)

17051 DIFFERENCES IN RADIOSENSITIVITY OF BARLEY SEEDS OF DIFFERENT RIPENESS DEGREE (CYTOLOGICAL ANALYSIS). Nuzhdin, N. I.; Pastushenko-Strelets, N. A. pp 30-6 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

The frequency of chromosome aberrations in cells of the primary roots of seedlings of γ-irradiated barley was studied. Air-dried seeds harvested at different stages of maturity and stored in ears under identical conditions throughout a year were given ^{60}Co γ radiation at a dose of 9 KR. It was established that there was a relation between the percentage of chromosome aberrations and the degree of maturity of the irradiated seeds. Mature seeds exhibited a higher frequency of bridges, while fragments occurred more frequently in immature seeds. The data suggest that radiosensitivity of barley seeds depends on the physiological state of seeds. (H.L.W.)

17052 THE INFLUENCE OF THE COMBINED EFFECTS OF GAMMA RADIATION AND SPACE FLIGHT FACTORS ON BARLEY SEEDS IN DIFFERENT PHYSIOLOGICAL STATES. Nuzhdin, N. I.; Dozortseva, R. L. pp 3-29 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

Dormant, air-dried barley seeds were γ-irradiated and taken on board the Voskhod-1 spacecraft along with non-irradiated seed The effects of space flight factors on seed germination and on chromosome aberrations were studied. Previous investigations indicated that space flight stimulated germination and increased the frequency of chromosome aberrations. Soaking cells in cysteine solution prior to germination reduced the number of cells containing chromosome aberrations. It was concluded that space flight did not influence germination or the production of chromosome aberrations. (H.L.W.)

17053 INFLUENCE OF ECOLOGICAL CONDITIONS OF PLANT GROWING ON SEED RADIOSENSITIVITY. Nuzhdin, N. I.; Pastushenko-Strelets, N. A. pp 37-49 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

The dependence of seed radiosensitivity on the ecological conditions of plant growing was investigated. Seeds of two spring barley varieties Mockovsky 121 and Nemchinovsky were grown prior to radiation in six areas with different ecological conditions. The seeds grown in these regions were irradiated in the next year with ^{60}Co gamma rays in doses of 6, 9, and 12 KR and then planted in Moscow. Non-irradiated seeds of the same year were used as controls. A criterion for radiosensitivity in the zero experiment was zero seed germination and plant survival. It was shown that seed germination and plant survival differ widely, depending on the growing conditions before the irradiation. The incidence of chromosomal aberrations in primary root cells also depends on growing conditions of parent plants. One of the major factors leading to differences in seed radiosensitivity is different intensity of ultraviolet radiation. (auth)

17054 EFFECTS OF GAMMA-RAYS AND CHEMICAL MUTAGENS ON BARLEY SEEDS. Nuzhdin, N. I.; Samokhvalova, N. S. pp 50-89 of Eksperimental'nye Raboty po Vliyaniyu Ioniziruyushchikh Izluchenii na Organizm. Nuzhdin, N. I. (ed.). Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

Barley seeds in organic and induced dormancy were treated with physical (gamma rays) and chemical mutagens (NMH, MH and EI). A cytological analysis of the seed roots revealed a pattern common to gamma rays, MH and EI, namely the dependence of their effects on the physiological state of the seeds. Experiments involving fractionated and combined treatments, modified by various factors, were carried out. The results obtained suggest that the ultimate effect of combined treatment depends on the sequence in which the mutagens were used. (auth)

17055 ANALYSIS OF LETHAL RESPONSES IN OEDOGONIUM CARDIACUM IRRADIATED AT DIFFERENT CELL STAGES. Horsley, R. J.; Banerjee, S. N.; Banerjee, M. (Ontario Cancer Treatment and Research Foundation, Hamilton). Radiat. Bot., 7: 465-76(Dec. 1967).

The non-surviving progeny from Oedogonium sporelings were studied following increasing doses of x radiation up to 16 kR given at the G_1, S, G_2 and M stages during the first cell cycle. Radiosensitivity was measured by three expressions of radiation damage, viz. giant cells, nuclear fragmentation, and anucleate cells, and is compared with the radiosensitivity of these cells as measured by loss of reproductive ability. There is a correlation between loss of cell reproductive ability and radiation damage leading to giant cell formation both of which are maximum in cells irradiated in G_2. No correlation is observed between loss of cell reproductive ability and nuclear fragmentation or anucleate cell formation. Loss of cell reproductive ability includes all forms of lethal radiation damage, whereas radiosensitivity measured by any single criterion reveals only a part of the total damage. Therefore, the data for different expressions of radiation damage may not parallel the findings based on loss of cell reproductive ability. It is also concluded that in Oedogonium the response patterns for particular expressions of radiation damage depend both on dose and cell stage at the time of irradiation. (auth) (UK)

17056 EFFECT OF PRESOWING ^{60}Co γ-IRRADIATION OF LUPINE SEEDS ON ALKALOID ACCUMULATION. Mironenko, A. V.; Polishchuk, N. E. (Inst. of Experimental Botany, Minsk). Dokl. Akad. Nauk BSSR, 11: 71-3(Jan. 1967). (In Russian).

Irradiation of seed of narrow leaf and yellow lupine by ^{60}Co γ rays influences the content and qualitative composition of alkaloids in the plant. Moreover, the pre-sowing irradiation does not change the whole alkaloid content only the ratio between the components. Irradiation of high-alkaloid narrow leaf lupine No. 484 reduced the alkaloid content of the leaves during budding, depending on the dose, up to 22 to 26%. Irradiation of yellow lupine seed of the No. 6 type reduced from 30 to 50% of alkaloid content of the budding leaves. In yellow lupine No. 3 the 500 R dose reduced the content of alkaloids by 29%. (R.V.J.)

Radiation Effects on Microorganisms

Refer also to abstracts 16973, 16974, and 16978.

17057 THE VITAL ACTIVITY OF CHLORELLA UNDER SPACEFLIGHT CONDITIONS. Shevchenko, V. A.; Sakovich, I. S.; Meshcheryakova, L. K.; Petrovnin, M. G. Kosm. Biol. Med., 1: 25-8(1967). (In Russian).

The possibility of using Chlorella as a link in a closed ecological system for spacecraft requires study of the effect upon it of such spaceflight factors as ionizing radiation, vibration, and weightlessness. Controlled studies have been made with laboratory material and with material subjected to spaceflight. Viability and mutability of various strains of Chlorella vulgaris Beyer obtained from the Institute of General Genetics, USSR Academy of Sciences, and subjected to the 22-day Cosmos-110 orbital flight were studied. The strains were distinguished by such morphological indices as reproductivity, thermostability, and radiosensitivity. Synchronous, sterile suspensions of each strain (density $1 \cdot 10^6$ cells/ml; volume 2 ml) in Tamiyya medium were sealed in glass ampoules and special opaque containers and placed on board the spacecraft. After the flight the Chlorella samples were seeded on agar and studied by the methods of micro- and macrocolonies. With the former, sporulation and viability in comparison to controls were observed, while mutations were detected with the latter method. For the sake of accuracy, 400 colonies were studied in each case. The incidence of mutation in experimental and control samples showed only insignificant differences. The dynamics of the first sporulation were also studied and though the process was occasionally delayed in experimental specimens, the rate normalized completely by the end of the second sporulation. The data obtained in this study are in accord with analogous data obtained from the Cosmos-109 flight, even though that flight did not cross the earth's inner radiation belts and the radiation dose was 100 times smaller than that received by the Cosmos-110 spacecraft. In both cases, mutation rates were within normal limits. Use of more sensitive methods in such studies is suggested. Also, it is known that a dose of at least 1 krad of ionizing radiation is required to produce a noticeable effect on biomass increase. It is concluded that spaceflight, prolonged to the extent of 22 days, has no particular effect on the viability and mutation processes of the Chlorella strains studied. (ATD)

17058 OBSERVATIONS ON THE MECHANISM OF INDIRECT INDUCTION BY MATING WITH ULTRAVIOLET-IRRADIATED COL I DONORS. Monk, Marilyn (Univ. of Leicester, Eng.). Mol. Gen. Genet., 100: 264-74(1967).

Irradiation of the col I donor itself is required to initiate indirect induction of phage λ following mating with a lysogenic recipient. Attempts to demonstrate that some other cytoplasmic inducer is responsible for induction were negative. However the level of transfer of a viable (colicin-producing) col I factor (to a non-lysogenic recipient) is not correlated with the transfer of indirect induction (to a lysogenic recipient) either with respect to relative uv sensitivities, or relative kinetics. Transfer of viable col I factor from the irradiated donor is delayed for up to 40 min whereas indirect induction is initiated early after contact. There is some lethality and inhibition of division of recipient cells mated with the irradiated donor, these effects similarly being initiated extremely early after cell contact. The question as to whether these effects of mating with an irradiated donor on the recipient follow transfer of inviable col I, or reflect a disturbance of transfer itself remains unresolved. (auth)

17059 THE INTERFERENCE ACTIVITY OF ULTRAVIOLET-IRRADIATED NEWCASTLE DISEASE VIRUS (NDV_{uv}). Russeff, Christo; Mateva, Vora; Wassilewa, Lilia (Veterinary Inst. of Infectious and Parasitic Diseases, Sofia). Zentralbl. Bakteriol. Parasitenk., Abt. 1 Orig., 198: 391-404(Dec. 1965). (In German).

The interference activity of nonpathogenic and virulent strains of Newcastle disease virus (NDV), for calf kidney cells in vitro, was studied using uv to inactivate the two strains of virus. It was shown that in the nonpathogenic strain the interference activity is caused by interferon and not to elementary virus particles. On the contrary, the cytopathogenic NDV strain with high infectious titer, after uv irradiation, showed interfering activity that originated from the elementary virus particles themselves. The interfering activity of the supernatant of tissue cultures inoculated with the first strain was resistant to intensive uv irradiation, to acid (pH 2) dialysis, to neutralization by anti-NDV serum, and to ultracentrifugation at 105,000 g. However, this activity is sensitive to trypsin and was tissue specific. The interfering activity of NDV with high infectious titer obtained from chicken embryos after uv irradiation was resistant to trypsin and is lost after neutralization with anti-NDV serum. This activity is caused by the elementary virus particles themselves. The time of appearance, duration, and degree of the interference caused by NDV_{uv} in tissue cultures were determined. (BBB)

17060 NON-LETHAL NON-HEREDITARY CHANGES CAUSED BY ULTRAVIOLET IRRADIATION. Morozov, E. I. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk BSSR, 11: 79-80(Jan. 1967). (In Russian).

Measurements were made of the latent period in bacteriophage Tl irradiated by ultraviolet rays with 49 erg/mm^2/sec intensity. The data obtained indicate that ultraviolet rays induce in Tl phage certain disturbances that are expressed latently. (R.V.J.)

Radiosterilization and Radiopreservation

Refer also to abstracts 16632, 16636–16639, 16741, 16744, 16779, and 17050.

17061 (COO-1592-10A) IRRADIATION OF FRUITS AND VEGETABLES. Progress Report, April 16, 1966–April 15, 1967. Markakis, P.; Nicholas, R. C.; Schweigert, B. S. (Michigan State Univ., East Lansing. Dept. of Food Science). May 11, 1967. Contract AT(11-1)-1592. 23p. Dep. CFSTI.

Experiments were performed to determine the effect of γ radiation from a ^{60}Co source on the preservation of fruits and vegetables. Apple juice, asparagus, blueberries, cherries, mushrooms, strawberries, and sweet corn were the commodities studied. The irradiation of mushrooms retarded the opening of the mushroom caps during storage, and proved to be the most promising of the food irradiation experiments. The effect of γ radiation on the growth of yeasts in fruits was also studied. (L.C.L.)

17062 (MIT-3343-28) THE EFFECT OF GAMMA RAYS ON OCEAN PERCH INOCULATED WITH TYPE E, CLOSTRIDIUM BOTULINUM. Annual Report, June 1966–June 1967. Goldblith, S. A.; Nickerson, J. T. R. (Massachusetts Inst. of Tech., Cambridge). Jan. 1968. Contract AT(30-1)-3343. 75p. Dep. CFSTI.

Samples of irradiated haddock were inoculated with Pseudomonas fragi and type E Clostridium botulinum and incubated at 45°F. The samples became toxic in ten days. Tests were made for the toxicity of TPG-haddock broth inoculated with Ps. fragi and Cl. botulinum or with Achromobacter species and type E Cl. botulinum incubated aerobically at 45°F. The fragi-botulinum-inoculated samples became toxic in 15 to 20 days and the Achromobacter-botulinum-inoculated samples became toxic in 20 to 25 days. Tests made with haddock fillets inoculated with spores of Cl. botulinum, irradiated at 200 krad, and held at 75°F for ten days showed that when activated with trypsin, these fillets contained about 5,000 LD_{50} mouse units of toxin per 0.5 g. Such fillets were cooked for 3 min at 375°F, and after this treatment did not contain sufficient toxin to kill any of the mice injected intraperitoneally with the trypsinized or nontrypsinized extract. Tests to compare the lethality of C. botulinum toxin in mice fed orally and injected intraperitoneally showed that injection was 50 to 100 times more lethal than oral feeding. Tests were made with a small expert panel to determine the storage life of cod fillets irradiated at 100 or 200 krad, and held at 38, 42, or 45°F. The results indicated somewhat shorter storage life times than those obtained by the Fish and Wildlife Service using total rejection by an untrained panel as criteria. Toxicity tests were completed for ocean perch inoculated with spores of C. botulinum, non-irradiated, or irradiated at 150, 250, or 350 krad, and held at 40, 45, or 50°F. Irradiated samples either contained toxin at the same time as the control or were nontoxic for longer periods than the control in most cases. (H.L.W.)

17063 POTENTIAL ROLE OF RADIATION IN ALLEVIATING SOME WORLD FOOD PROBLEMS. MacQueen, K. F. (Atomic Energy of Canada Ltd., Ottawa). Isotop. Radiat. Technol., 5: 126-36(Winter 1967-68).

Irradiation, the first revolutionary technique for food preservation in over 150 years, produces many useful effects, e.g., inhibition of sprouting in vegetables, delay of ripening in fruits, control of insect infestations in cereals and dried foods, and destruction of microorganisms in fish, meats, and other foods. How these useful effects would improve the storage and distribution of various food products that may be largely wasted but are vitally needed by those suffering from hunger and malnutrition is illustrated here. With increased support for research and training, the new technology of food irradiation is expected to contribute to alleviating the food deficiency that affects over half the world's population. (auth)

17064 RADIATION PRESERVATION OF PACIFIC COAST FISHERIES PRODUCTS. Miyauchi, D.; Spinelli, J.; Pelroy, G.; Steinberg, M. A. (Bureau of Commercial Fisheries Technological Lab., Seattle). Isotop. Radiat. Technol., 5: 136-41(Winter 1967-68).

Results of experimental work at the U. S. Bureau of Commercial Fisheries Technological Laboratory, Seattle, during the last five years are presented. Irradiation of Northeast Pacific Ocean marine products with doses of 0.1 to 0.2 MRad gives acceptable products with shelf life sufficient to allow marketing anywhere in the United States. Taste panels detected no significant difference between frozen fresh fish and irradiated fish stored four weeks in preference tests. Fish can be irradiated in retail packages or in large wholesale units. Some products require using oxygen-impermeable packaging materials and eliminating the air by vacuum packing or complete filling of the package to prevent oxidative rancidity. Helium atmosphere during irradiation gave effects similar to vacuum packing; nitrogen, air, and carbon dioxide atmospheres were detrimental. The effect of storage temperature on microflora is still being studied. Treatment with sodium tripolyphosphate helps retain original appearance and texture. (auth)

17065 SEVENTH ANNUAL AEC FOOD-IRRADIATION CONTRACTORS' MEETING. McKinney, F. E. Isotop. Radiat. Technol., 5: 220-4(1968).

Reports presented at the annual meeting, September 27, 1967, on fruits, vegetables, marine products, microbiology, and wholesomeness of irradiated foods are summarized. The Division of Isotopes Development contractors gave 19 reports, and the Division of Biology and Medicine contractors gave 21 reports. Several products are lacking only the Food and Drug Administration approval to become commercialized. (H.L.W.)

17066 STUDY OF IRRADIATED-PASTEURIZED FISHERY PRODUCTS. OPERATIONAL GUIDE FOR MARINE PRODUCTS DEVELOPMENT IRRADIATOR. Ronsivalli, L. J.; Carver, J. H.; Kaylor, J. D.; Huff, J. B.; Murphy, E. J. (Bureau of Commercial Fisheries, Gloucester, Mass.). Isotop. Radiat. Technol., 5: 224-33(1968).

The annual report to the USAEC by the Bureau of Commercial Fisheries Technological Laboratory, Gloucester, Mass., on radiation pasteurization of marine products is summarized. During the past year, consumer acceptance and optimum dose (250 krads) were tentatively established for blue-crab meat and scallops. The effect of preirradiation quality on postirradiation shelf life was investigated; cod could be stored ten days and clam meats seven days before irradiation became uneconomic. Analytical chemical methods were used to study the odors and flavors in clam meat and haddock. Operation of the Marine Products Development Irradiator was described. A survey determined that product temperatures of less than 40°F were maintained by current fish-distribution methods. (auth)

17067 PRESERVATION OF FOOD BY IONIZING ENERGY. Sacharow, Stanley. British Food J., 69: 76-8(May -June 1967).

On June 1, 1967, new regulations controlling the use of ionizing radiations for the treatment of food came into operation in the United Kingdom. In general these regulations prohibit the use of ionizing radiations, but provide machinery for the consideration of exemptions from the prohibition. The author outlines progress in the use of ionizing radiation for the preservation of fish, fruit and vegetables, cured meats, and fresh meat and poultry (mainly American practice). The need for 15 to 20 years of research is foreseen to establish the widespread use of radiation preservation, but this period might be reduced with the help of medical scientists. (auth)

17068 NEW WAYS TO CONTROL INSECTS. Nelson, Stuart O. (Dept. of Agriculture, Washington, D. C.). Farm, Ranch, Home Quart., No. 132, 15-16(Summer 1966).

The use of electromagnetic, sonic, and ultrasonic energy to control insect pests is discussed. Gamma and x radiation were used to eradicate the screwworm and the melon fly after administration of doses sufficient to cause reproductive sterilization. Insect light traps were used to control the tobacco hornworm populations. Grain beetles were killed by γ rays, radiofrequency electric fields or infrared radiation without damaging effects to the nutritional qualities of the grain. The possibility of using sound and ultrasound for insect control through influencing behavior is suggested. (F.M.M.)

17069 STERILIZATION OF LABORATORY ANIMAL DIETS BY GAMMA RADIATION. Vet. Rec., 80: 446(Apr. 8, 1967).

Recent advances in the United Kingdom in use of γ radiation to sterilize animal foods are briefly reviewed. Radiation sterilization of diets after packaging in hermetically sealed containers offered marked advantages over other methods. A dose of 2.5 Mrad for sterilization was found effective, but whether such treatment destroyed vitamins, altered the nutritive value of the diet, or produced toxic products had to be determined. With regard to possible effects on the vitamin content, small losses did occur, but were unlikely to be sufficiently serious to present a nutritional hazard. With the exception of vitamin E, that was the most seriously affected, there were only minimal losses in animal diets of natural ingredients after irradiation. Although there was no evidence that the nutritive value of the food was reduced, its flavor could be affected, a temporary reduction in food intake being observed when animals previously fed ordinary diet were given irradiated diet. Experiences with irradiated diet when used exclusively as a source of food for rats showed that over a period of six yr their growth rate, reproduction, and longevity were not significantly affected. Similar results were obtained over a period of two yr with colonies of guinea pigs and rabbits. Packaging of diets, and the costs of irradiation were also considered. (BBB)

17070 RADIATION CONTROL OF THE HOLLYHOCK SEED MOTH (LEPIDOPTERA, GELECHIIDAE). Azaryan, G. Kh.; Babayan, A. S.; Vasilyan, V. V.; Mkrtumyan, K. L. Entomol. Obozrenie, 44: 762-9(1966). (In Russian).

Pupae of the hollyhock seed moth (*Platyedra malvella*) were x-irradiated at various ages. The one and two day old pupae were the most radiosensitive. With a dose of 5000 R, 100% sterility was obtained following matings of irradiated males and unirradiated females. There was no difference between radiosensitivity of moths of summer and winter generations. The period of oviposition in moths hatched from irradiated pupae was considerably shorter than in those hatched from non-irradiated pupae. The life span of moths hatched from irradiated and non-irradiated pupae was approximately equal and was not affected by radiation dose or age of pupae. (H.L.W.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 16736 and 16828.

Corrosion and Erosion

Refer also to abstracts 17100, 17118, and 17131.

17071 (AECL–2784) EFFECT OF pH ON THE WEAR CHARACTERISTICS IN WATER OF TEN METAL COMBINATIONS. Ogunlade, O. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1967. 37p. Dep. CFSTI. CAN $1.00.

The room temperature wear characteristics of ten journal sleeve metal combinations were investigated in pH 10 water and compared with results in pH 7 water. The ten combinations were randomly selected from those which had been tested successfully for at least two million inches of travel under laboratory conditions. The results of tests in pH 10 water were similar to the results of tests in pH 7 water. (auth)

17072 (AECL–2797) EFFECT OF WATER CHEMISTRY ON THE OXIDATION OF ZIRCONIUM ALLOYS UNDER REACTOR RADIATION. Lesurf, J. E.; Bryant, P. E. C. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Feb. 1968. 16p. Dep. CFSTI. CAN $0.50.

With pressurized water coolant, reactor radiation was reported to have no effect on the high-temperature oxidation of Zircaloy-2. In contrast, enhanced oxidation was reported from reactors where the water is allowed to boil. Corrosion information is presented for two zirconium alloys, Zircaloy-2 and Zr-2½% Nb, oxidized in reactor radiation by water containing excess oxidizing or reducing agents. Both oxidizing chemistry and damaging radiation (e.g. fast neutrons) are required to enhance the oxidation of Zircaloy-2; oxygen in the absence of neutrons has little or no effect, and neutrons do not result in enhanced oxidation under reducing chemistry conditions. The sensitivity of Zr-2½% Nb alloy to radiation and water chemistry depends on its metallurgical structure but, in general, it is sensitive to oxygen under all environments. Radiation appears to have no accelerating effect on Zr-2½% Nb oxidation other than that associated with oxygen production from the radiolysis of water. Addition of ammonia to the water being irradiated prevents the appearance of molecular oxygen out-reactor and reduces the oxidation of both Zircaloy-2 and Zr-2½% Nb. (auth)

17073 (MTI–68–TR–13) SELECTION AND EVALUATION OF MATERIALS FOR STEAM LUBRICATED BEARINGS. Murray, S. F.; Orcutt, F. K. (Mechanical Technology Inc., Latham, N. Y.). Feb. 1968. Contract AT(30-1)-3839. 57p. (NYO–3839-1). Dep. CFSTI.

An experimental study was made to select material combinations for use in steam-lubricated bearings. Major emphasis was placed on the use of wear-resistant plasma coatings, sprayed on corrosion resistant substrates. These coatings have outstanding resistance to damage during high speed rubs, simplify design and fabrication problems, and have shown promise in actual steam bearings. A number of candidate materials and coatings were selected for evaluation. They were solid Stellite 6B, a sprayed Stellite 6 coating, two metal-bonded carbides, two self-bonded oxides, and plain annealed 410 stainless steel. Static erosion tests were run on these materials with the results that nickel chrome-bonded chrome carbide coating gave the best overall results: nickel-bonded carbide on a hardened steel substrate showed good resistance to erosion damage around the feedhole; and Stellite 6 coating was promising for the impingement surface. High speed rub tests were made on nickel chrome-bonded chrome carbide versus itself and stellite coating versus nickel-bonded tungsten carbide. The chrome carbide coating appears to be the best choice for use in steam-lubricated bearings. (L.C.L.)

17074 VARIABILITY IN CO_2 OXIDATION RESISTANCE OF 2¼ Cr 1 Mo AND 1 Cr ½ Mo STEELS. Harris, R. J.; Menzies, J. A. (Nuclear Design and Construction, Ltd., Whetstone, Eng.). Brit. Corros. J., 3: 34-46(Jan. 1968).

Oxidation tests in CO_2 atmospheres on nominally identical casts of low alloy steels revealed wide variation in oxidation resistance. A study was made of the influence of chemical composition, mechanical and thermal treatment, and remelting on the CO_2 oxidation behavior of steels of the 2¼ Cr 1 Mo and 1 Cr ½ Mo type. Statistical analyses of CO_2 oxidation results showed a strong positive correlation of oxidation rate with sulphur content in certain instances, but a number of anomalies were found. A similar relationship was obtained between "MnS" content and oxidation rate by area count studies of the inclusions in a range of 2¼ Cr 1 Mo steels. These studies also indicated a possible effect of "MnS" particle size and particle size distribution, which could account for some of the anomalous results obtained in the statistical work. Conventional solid-state heat treatments appear to have no significant effect on the oxidation behavior of 2¼ Cr 1 Mo, and while remelting in argon did not generally improve oxidation behavior, remelting in vacuo followed by forging and rolling resulted in a material of high oxidation resistance. (auth)(UK)

17075 CORROSION OF LOW ALLOY STEELS BY CARBON DIOXIDE AT MODERATE TEMPERATURES. Loriers, H.; Leclercq, D.; Darras, R. (CEN, Saclay, France). J. Nucl. Mater., 25: 144-59(Feb. 1968). (In French).

The corrosion of ten low alloy steels in high pressure carbon dioxide has been studied up to 550°C because of their use in graphite or heavy water moderated carbon dioxide cooled nuclear reactors. An accelerated attack affects particularly the ½% Cr-½% Mo steel, but does not spare most of the other steels in the more drastic conditions (wet CO_2, higher temperatures). The occurrence of an irregular attack and the formation of excrescences on the samples, observed in many cases, has been related to the composition and pressure of the corroding medium and to the metal surface conditions. Interest is given to the 2¼% Cr-1% Mo steel which has suitable corrosion resistance up to 525°C. In an attempt to explain the phenomena, oxide scales and metal scrapings have been examined by microscopy, x-ray diffraction, and electron microprobe analysis. Hypothesis on the mechanisms of excrescences formation and breakaway oxidation are discussed. (auth)

17076 THE KINETICS AND MECHANISM OF THE OXIDATION OF ZIRCALOY-2 AT 350 TO 500°C. Dawson, J. K.; Long, G.; Seddon, W. E.; White, J. F. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 25: 179-200(Feb. 1968).

An analysis of the kinetics of reaction of Zircaloy-2 with oxygen and water vapor in the ranges 20 to 200 torr and 350 to 500°C is reported, based upon continuous measurements of the progress of oxidation by both gravimetric and manometric techniques. The study included the transient effects of changing some of the conditions of oxidation (temperature, pressure), the measurement of surface area at various stages of oxidation and microscopy. The kinetics could be divided into four distinct ranges of weight gain, progressing from parabolic through cubic to linear relationships, the weight gains at the transitions being dependent upon temperature. A model is developed which describes the mechanism of oxidation and in particular offers a simple explanation of the cubic rate law in terms of cracking along or near the oxide/metal interface. (auth)

17077 SODIUM TECHNOLOGY IN JAPAN. Kawahara, S. (Hitachi Research Lab., Tokyo); Furukawa, K.; Sako, K. pp 809-24 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

From small scale loop tests preliminary results were obtained for dynamic corrosion of types 304, 316 and 347 stainless steels, 2¼Cr-1Mo steel, and other metals. In experiments at low Peclet numbers, heat transfer coefficients were low compared with theoretical values. Sodium purification, using cold and hot traps, was investigated by several methods including direct observation in a glove box. A relation between temperature and the distribution of trapped oxide was obtained. A brief outline is given of a 2 MW loop design intended for the examination of components for an experimental fast reactor. A supplement describes tests in two new "daughter" loops. In improved mass transfer experiments type 316 stainless steel was superior to type 304, and 2¼Cr-1Mo steel gave good results on the cold side. In the second loop a bellows of type 316L steel was used as a separator for the detection and separation of hydrogen. (UK)

17078 INTERACTION OF RARE-EARTH OXIDES WITH SODIUM–BORATE MELTS. Dzhurinskii, B. F.; Belyakov, I. M.; Tananaev, I. V. (Inst. of General and Inorganic Chemistry, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1876-80 (Oct. 1967). (In Russian).

By the method of isothermal saturation at 900°C the solubility in the system $Na_2O-B_2O_3-Ln_2O_3$(Ln = Sm, Gd, Tb, Dy, and Er) was determined. The composition of the solid phase was characterized. By differential-thermal analyses, the thermal stability of the metaborates of the $Ln(BO_2)_3$ type was determined. It was shown that the temperature of fusion of the metaborates decreases in the series from La to Tb. (tr-auth)

17079 THE OXIDATION OF TUNGSTEN AT HIGH TEMPERATURES. THE SYSTEM W + CO_2. Cismaru, D.; Geangu-Moisin, Angela (Centre of Physical Chemistry, Bucharest). Rev. Roum. Chim., 12: 1425-8(Dec. 1967).

Studies were carried out on the oxidation of tungsten from 600 to 1000°C and for 0.1 and 0.032 atm CO_2. The results showed that at these pressures of CO_2, the oxidation is governed by equilibrium conditions of the systems produced by the initial system W + CO_2. The rates are in good agreement with the parabolic law of the whole temperature and pressure range of the experiments. The variation of the rate constants with temperature follows the Arrhenius law up to 1000°C; the rate constants at 1000°C are lower than that at 900°C. The value of these constants are lower than those obtained by others under similar conditions of temperature and pressure, but in O_2 atmosphere. The activation energies were found to be 7,770 cal/mol for $p_{CO_2} = 0.1$ atm and 7,410 cal/mol for $p_{CO_2} = 0.032$ atm. The effect of CO_2 pressure was marked by the increase in oxidation rate. (auth)

17080 KINETICS OF OXYGEN TRANSFER FROM CO_2 TO THE SURFACE OF METALS. Grabke, H.-J. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Ber. Bunsenges. Phys. Chem., 71: 1067-73(Dec. 1967). (In German).

The rate of oxygen transfer from CO_2 to the surface of the metals Au, Ag, Pd, Cu, Ni, Co, Fe, and W was determined in a flow apparatus at high reaction temperatures (about 1000°C) and for equilibrium conditions with the aid of tagged carbon dioxide. The oxygen activity a_O at the metal surface was determined by the ratio p_{CO_2}/p_{CO}. The reaction at the more noble metals was independent of the oxygen activity (m = 0). For the reaction on Co, Fe, and W $m > 0$ was valid, that is, the oxygen transfer was retarded by a high oxygen coverage. The apparent activation energies and frequency factors were determined and discussed. The relative activities of the metals increased with the enthalpy of formation of their oxides up to a maximum for Co and decreased again for Fe and W, which may be caused by the retarding effect of chemisorbed oxygen. (auth)

17081 EFFECT OF LIQUID SODIUM ON WELDED AISI TYPE-304 STAINLESS-STEEL PIPE. Ratz, G. A.; Brickner, K. G. (United States Steel Corp., Monroeville, Pa.). Nucl. Appl., 4: 154-8(Mar. 1968).

An investigation of a sample of welded AISI Type-304 stainless-steel pipe exposed to liquid sodium at 572 to 1472°F for ≈ 7800 h and an unexposed sample of pipe from the same heat of Type-304 steel showed that, except for nitrogen, no marked change in composition of the pipe occurred. Nitrogen was absorbed at the surfaces of the pipe, a greater amount being absorbed at the inside surface that had been exposed to the liquid sodium, than at the outside surface that had been exposed to air. Under the conditions studied, the steel did not undergo any marked deleterious change in mechanical properties. However, the absorption of nitrogen did decrease the ductility of the surface that had been in contact with the liquid sodium. Thus, when Type-304 steel is used for liquid-sodium service, precautions should be taken to keep the sodium as free as possible from nitrogen-containing contaminants. (auth)

17082 IN-REACTOR SODIUM CORROSION OF VANADIUM AND VANADIUM-TITANIUM ALLOYS. Greenberg, S.; Cheng, C. F.; Ruther, W. E. (Argonne National Lab., Ill.). Nucl. Appl., 4: 170-2(Mar. 1968).

Vanadium-titanium alloys, exposed to flowing sodium in the EBR-II core suffered small weight losses. In contrast to the behavior of these materials when exposed to ex-reactor, no hardened layers were produced. (auth)

17083 PREDICTING THE INTERGRANULAR CORROSION OF AUSTENITIC STAINLESS STEELS. France, W. D. Jr.; Greene, N. D. (Rensselaer Polytechnic Inst., Troy, N. Y.). Corros. Sci., 8: 9-18(Jan. 1968).

The precise environmental conditions for the intergranular corrosion of austenitic stainless steels were determined by potentiostatic methods. Intergranular corrosion of sensitized 18 Cr–8 Ni stainless steel only occurs in limited potential regions. These results were used to develop a new method for rapidly predicting the intergranular corrosion tendencies of the steels in various sulphuric acid environments. It is also shown that sensitized stainless steels may be used in many media without the occurrence of intergranular attack. (auth) (UK)

Preparation and Fabrication

Refer also to abstracts 16748, 17118, and 17172.

17084 (66-C-318) POROUS BODIES OF TANTALUM, NIOBIUM, AND ALUMINUM FABRICATED BY METAL-SPRAY PROCESSES. Rairden, J. R. (General Electric Co., Schenectady, N. Y. Research and Development Center). Aug. 19, 1966. 6p. Dep. CFSTI.

Free-standing, porous bodies of high-purity tantalum, niobium, and aluminum can be fabricated by plasma arc spraying powders in an argon atmosphere. Porosity in these bodies is achieved by using a long gun-to-mandrel distance. The available surface area of these porous materials is shown to be comparable to those obtained by powder pressing and sintering techniques. Porous aluminum also can be fabricated by using a wirefeed metallizing gun. (auth)

17085 PREPARATION OF SOUND HIGH PURITY PLUTONIUM RODS. PART I. EFFECT OF CHILL CASTING AND SUBSEQUENT HEAT TREATMENT ON MICROCRACKING. Harbur, D. R.; Romero, J. W.; Anderson, J. W.; Maraman, W. J. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 25: 160-5 (Feb. 1968).

The severe microcracking in high purity plutonium metal rods is eliminated by a chill casting procedure and a post-casting treatment. Multiple cast rods, 6 to 17 mm in dia with densities in excess of 19.79 g/cm^3 are produced by pouring the plutonium melt at 800 ± 50°C in vacuo into an aluminum alloy mold chilled to −80°C. Cold shuts are eliminated through the use of a distribution runner on top of the mold which allows only one rod cavity to be filled at a time. The final high density is achieved by warming the rods to 80°C immediately after casting, followed by cycling the rods between 80 and 25°C for 2 days. (auth)

17086 PRESSURE WORKING OF THIN-WALLED PARTS OF MOLYBDENUM. Korolev, V. N. Kuznechno-Shtampovochnoe Proizvod., No. 1, 21-2(Jan. 1967). (In Russian).

Spin forming of thin Mo cups (for electronics), 0.1 to 0.2 mm in thickness, is done using rolls or stationary forming tools of bronze or tool steel. Prior to spinning and after it, the metal is vacuum annealed for stress relief. Selection is made of the optimum rotation rates and pressures of the forming tools to provide for uniform thickness and quality surface finish. (Rev. Metal Lit.)

17087 CONDITIONS FOR ELECTRODEPOSITION OF Ni–Nb ALLOY COATINGS AND THEIR PHYSICO-CHEMICAL PROPERTIES. Kalyuzhnaya, P. F.; Pimenova, K. N.; Gavrilova, Z. P. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh., 33: 327-33(1967). (In Russian).

Electrodeposition of Ni–Nb alloys and the dependence of the physicochemical properties of obtained deposits and foil on the nature and composition of the electrolytes used have been investigated. Graphite and Ni–Nb alloys were used as anodes. The cathodes were made from Cu, Armco-iron or steel. Citric acid, niobate or fluoroniobate solutions were found to be the most stable electrolytes, which also produced dense, uniform deposits. Dense, uniform deposits of Ni–Nb alloys containing up to 0.2% Nb were obtained from a citrate electrolyte at 20°C, a pH of 0.6, a current density of 2 to 4 amp/dm^2 and a current efficiency of about 67%. Ammonium citrate solution (150g/l) was used as the anolyte with a pH equal to that of the catholyte. Analogous results were obtained also from alkali niobate electrolytes. Dense, fine-grained Ni–Nb alloy deposits containing up to 0.07% Nb were obtained at the electrolyte temperature of 20°C, a pH of 8.0 to 12.0, a current density of 2 to 6 amp/dm^2 and a current efficiency of 36 to 96%. High quality Ni–Nb deposits up to 5μ thick containing up to 3% Nb were obtained from a fluoroniobate electrolyte containing 59g/l K_2NbF_7 (18g/l Nb_{met}) and 140g/l (0.5 mol/l) $NiSo_4 7H_2O$ at a current efficiency of 42 to 64%. Deposits thicker than 0.5μ exhibited noticeable inner stresses which, on the basis of the x-ray structural analysis can be ascribed to the interaction between Nb and O and H. In 5%HCl at 20°C, corrosion resistance of Ni–Nb coatings with a low Nb content was about the same as that of Ni coatings, while deposits containing 3% Nb had corrosion resistance 3 to 4 times lower than that of Ni. Corrosion resistance of obtained Ni–Nb foil containing 1.3% Nb was two times as high as corrosion resistance of Ni–Nb foil made by the metallurgy method. The low corrosion resistance of electrodeposited Ni–Nb coatings results from introduction of O and H impurities during electrodeposition. Thus, two-component Ni–Nb alloy deposits containing up to 3% Nb can be obtained from aqueous solutions but they cannot be used as protective coatings because of their low corrosion resistance. (ATD)

17088 PREPARATION AND PROPERTIES OF CuCr AND CuCrZr. Langner, Rainer; Rust, Klaus. Neue Huette, 12: 550-5(1967). (In German).

In alloys of CuCr and CuCrZr, the homogenization temperature has a decisive effect on the maximum hardness attainable. The homogenization time can be very short. The relations between annealing time and scaling thickness or thickness of the diffusion layer were determined at an annealing temperature of 1030°C. Thick diffusion zones lead in the drawing to fine fissures at the surface of the material. The softening temperature and the heat resistance of CuCrZr is greater than that of CuCr. (tr-auth)

17089 CONTRIBUTION TO THE STUDY OF THE FACTORS WHICH MODIFY THE SHAPE AND DIMENSIONS OF WELDS OBTAINED BY ELECTRON BOMBARDMENT. Boncceur, M.; Rápin, M. (Commissariat a l'Energie Atomique, Essonne, France). Mem. Sci. Rev. Met., 64: 953-64(Nov. 1967). (In French).

Welds formed by electron bombardment of stainless steel and uranium were studied. Factors influencing the shape and dimensions include the distance separating the surface of the workpiece from the electronic image on the shape, depth and surface of the metal pool, and the effects of specific power and beam convergence on the surface of the workpiece. (tr-auth)

17090 EUTECTIC TITANIUM AND ZIRCONIUM SOLDER. Takeuchi, Y.; Watanabe, M.; Yamabe, S.; Wada, T. (Tohoku Univ., Sendai. National Research Inst. for Metals, Tokyo). Metall, 22: 8-15(Jan. 1968). (In German).

A new eutectic-forming solder for the soldering of titanium, zirconium, and similar metals was developed. The laminated solder, is prepared by cold-rolling plating of the metal pairs forming eutectics. The pairs with Ni, Cu, and Fe are discussed. The laminated solder melts and flows in a vacuum at almost the same temperature as that corresponding to the melting point of the eutectic considered. Its wettability of titanium is satisfactory. In comparison with silver solder, the solder compounds with eutectic solders show a very high tenacity both at room temperature and at increased temperature, which is at least twice as high as that of silver solder. Its heat is good with a shearing strength of 20 kg/mm^2 at 400°C. The silver solder at the same temperature has a stability of only 10 kg/mm^2. Corrosion tests showed that the solder site is completely resistant to HNO_3 and H_2SO_4, whereas nickel-containing solders are more or less attacked by HCl. (tr-auth)

17091 FRICTION WELDING OF BI-METAL STUDS. Adams, D. F. Weld. Metal. Fabr., 36: 44-53(Feb. 1968).

A heat resisting material was required for threaded studs to hold the thermal insulation in position on the membrane lining the concrete pressure vessel of the Dungeness "B" AGR. Tests are described on stainless/mild steel bimetallic studs with a friction weld at the dissimilar metal joint in $^9/_{16}$ in. dia bar. Examination of samples formed by various weld sequence combinations included metallographic and hardness surveys, electron probe microanalysis, bend and tensile tests, and carbon migration studies. The integrity of the friction welded joint was demonstrated. The preferred welding conditions were: time 2½ sec, speed 1000 rpm, pressure (friction) 12,658 psi, pressure (forge) 50,633 psi. (UK)

17092 INFLUENCE OF LOW-TEMPERATURE ANNEALING AND URANIUM ADDITIONS ON THE ANTIMONY EMBRITTLEMENT OF BRASS. Thomson, R. (Dept. of Energy, Mines, and Resources, Ottawa). J. Inst. Metals, 96: 28-30(Jan. 1968).

Embrittlement of Cu and Cu–Zn alloys by trace amounts of Sb has been attributed to reversible segregation of Sb solute atoms at grain boundaries during slow cooling above 600°C. The effect of annealing and of U on Charpy V-notch impact properties was examined on specimens prepared from hot-rolled brass plates containing controlled additions of 0 to 0.22% Sb and 0 to 0.25%U. More than 0.04% Sb caused embrittlement, the extent of which was affected by thermal history, Sb content, and temperature of deformation. Annealing at 200 to 350°C rapidly increased the rate of embrittlement of quenched alloys containing 0.09% Sb. When the atomic concentration of U was equal or greater than that of Sb equilibrium segregation and embrittlement did not occur. Microexamination showed that Sb was removed from solid solution in the form of insoluble USb. (UK)

17093 NICKEL STEELS IN THE CONSTRUCTION OF THE OBRIGHEIM 300-MW NUCLEAR POWER STATION. Bull. Belgicatom, 12: Nos. 2-3, 35-6(July-Oct. 1967). (In French).

The reactor vessel of the Obrigheim nuclear power station is constructed of an alloyed steel containing ^{22}NiMo ^{37}Cr, with high resistance corresponding to ASTM 508 Class 2. All the interior surfaces of the vessel in contact with the primary coolant are protected against corrosion by a Nb stabilized Cr–Ni 18/10 stainless steel. The coating is also used for the pressurizer. Ni materials are used largely in the construction of two coolant pumps. (J.S.R.)

17094 VACUUM QUENCHING EQUIPMENT FOR HIGH TEMPERATURES. Guyot, H.; Daigne, B. (ONERA, Chatillon-sous-Bagneux, France). Mem. Sci. Rev. Met., 64: 973-9(Nov. 1967). (In French).

A description is given of an arrangement for heat treatment (1500 to 2000°C) and quenching of small specimens of refractory alloys. Treatment is carried out under secondary vacuum in an induction furnace. Experimental results and particular applications are given. (auth)

17095 ORIGINAL SPUTTERING PROCESS FOR SURFACE-COATING. Gibb, Michel. Euratom Bull., 6: 121-4(Dec. 1967).

A surface-coating process is described which enables a thin layer of metal or alloy to be deposited on a substrate of any kind. The process is suitable for forming anticorrosion coatings, diffusion barriers, electrically or thermally conductive coatings or optical and ornamental coatings. The process is an electrical discharge deposition technique involving cathode sputtering in a vacuum chamber in a low pressure gas atmosphere. Two electrodes are in the chamber, the cathode consisting of the material to be deposited and the anode is formed by the casing of the apparatus. A high voltage of 2000 to 4000 V is applied. The sample to be coated is located opposite the cathode. (F.S.)

17096 MOLYBDENUM GAS SEPARATION AT ELEVATED TEMPERATURES. Zagorskaya, T. N.; Ivanovskii, G. F.; Lyakhovich, T. K. Izv. Akad. Nauk SSSR, Metal., No. 1, 221-5 (Jan.-Feb. 1968). (In Russian).

The kinetics of gas-separation from molybdenum at high temperatures and 10^{-7} torr pressure are discussed. The evaluated amount of gases separated during heating and melting (depending on the amount of the initial composition) was 6×10^{-3} to 2×10^{-2} wt % H, 5×10^{-3} to 1×10^{-3} wt % C, and 2×10^{-3} to 9×10^{-3} wt % O. The emission of carbon oxide and dioxide was more intense at 1000 to 2000°C. The lowest gas separation in the high-vacuum thermal treatment of Mo was observed with specimens pretreated by zone melting at 10^{-5} torr. (R.V.J.)

17097 METHOD OF CLADDING A METAL SURFACE. Watson, R. D. (to Atomic Energy of Canada Ltd.). Canadian Patent 773,311. Dec. 12, 1967.

A method is described for cladding the inside of Zircaloy pressure tubes with Al to reduce in-service hydrogen pick-up. A 1S aluminum tube with a flared top and slightly smaller diameter than the Zircaloy tube was cleaned. The inside of the Zircaloy tube was cleaned and polished. The smaller tube was placed within the larger one having the flared top in contact at the upper end. Both tubes were heated to about 950°F and placed in a hydraulic press. A ram having a cylindrical head and a circular outwardly projecting portion was forced through the aluminum sleeve so that it bonds a lining of aluminum from 0.0045 to 0.025 in. thick on the inside of the Zircaloy tube. (F.S.A.)

Properties Evaluations

Refer also to abstracts 16553, 16757–16760, 16778, 16789, 16847, 17145, and 17604.

17098 (AEEW-M-797) DETERMINATION OF APPARENT DENSITIES OF PLUTONIUM DIOXIDE SPHEROIDS. Symons, W. J.; Robinson, B. K. (Atomic Energy Establishment, Winfrith (England)). Jan. 1968. 7p. Dep. CFSTI. UK.

The determination of the apparent density of production batches of plutonium dioxide spheroids produced by a sintering process is described. An evacuated density bottle is filled with mercury and weighed, with and without a weighed sample present. Results obtained on seven batches of plutonium dioxide gave an average density of 10.55 g/cc, with a relative deviation of ±1.2% at 1 sigma. (UK)

17099 (AERE-R-5639) THE MECHANICAL PROPERTIES OF HYDROGENATED ZIRCALOY-2 CONTAINING SELENIUM ADDITIONS. Walters, G. P. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1967. 13p. Dep. CFSTI. UK 3s. 0d.

The effect of selenium and hydrogen on the tensile properties of zirconium and Zircaloy-2 was studied. In both materials selenium and hydrogen have little effect on the 0.1% proof stress and ultimate tensile strength; they do, however, reduce ductility markedly. Optical metallography revealed hydride platelets in the grain boundaries, the precipitation characteristics being uninfluenced by the presence of selenium. Unhydrided specimens fractured along grain boundaries containing selenium; when hydrogen was present fracture occurred along boundaries containing hydride platelets. The zirconium/selenium alloys are expected to be susceptible to hydride stress re-orientation, and hence anisotropic ductility, in a similar manner to the conventional zirconium alloys used in water reactor systems. (auth) (UK)

17100 (BNL-50089) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 5, Number 5. (Brookhaven National Lab., Upton, N. Y.). Oct. 1967. 48p. Dep. CFSTI.

Information is presented on research and development programs devoted to high temperature liquid metal technology including materials development, corrosion and mass transfer, heat transfer, fluid dynamics, instrumentation, purification, component development, physical properties, thermodynamics, chemical analysis, and power systems. (J.C.W.)

17101 (BNWL-680, pp 25-6) PARTICLE SIZE OF AS-PRODUCED PROMETHIUM OXIDE. Roberts, F. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Particle sizes of Pm_2O_3 produced by oxalate decomposition by high temperature treatment were measured and the average size found to be 5 μ. Few particles were larger than 10 μ when measured at 1000× magnification with a microscope in a fume hood. (J.C.W.)

17102 (CU-2660-34) THERMODYNAMICS OF THE SYSTEM POTASSIUM/MERCURY. LaMantia, Charles R.; Bonilla, Charles F. (Columbia Univ., New York. Dept. of Chemical Engineering). Sept. 1, 1967. Contract AT(30-1)-2660. 41p. (CONF-680403-1). Dep. CFSTI.

For Presentation at 4th Symposium on Thermophysical Properties, College Park, Md.

Experimental measurements were made of the total vapor pressure of potassium amalgams and the emf of potassium amalgam concentration cells, both as functions of temperature and of amalgam composition. Vapor pressure measurements were made at twenty compositions, including pure mercury, at pressures up to 10 atmospheres. Emf data were obtained for six compositions between mercury mole fractions of 0.10 and 0.55 at temperatures up to 500°C. From these data, the pure component vapor pressure and P-V-T data, and a model for the interaction of the gas species, the following thermodynamic properties were calculated as functions of composition along the saturation curves at pressures of ½, 1 and 2 atmospheres: mercury and potassium activities in the liquid amalgams; differential heat of vaporization; liquid heat of mixing; composition of the vapor in equilibrium with the amalgam; and equilibrium vapor compressibility factor. (auth)

17103 (GA-7978) A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Final Summary Report, November 1, 1965-May 12, 1967. Chambers, R. H.; Firle, T. E.; Trozera, T.; Buzzelli, G. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 28, 1967. Contract AT(04-3)-167. 191p. Dep. CFSTI.

Twelve sections concerning programs of basic research on the mechanical properties of reactor materials are presented. A separate abstract was prepared for each paper. (J.C.W.)

For abstracts of individual sections see: 17104-17112 and 17137-17139.

17104 (GA-7978, pp 11-46) EXPERIMENTAL PROGRAM. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

High purity tungsten single crystals were produced from vapor deposited tungsten by electron-beam floating-zone refining. Electrical resistivity ratio measurements were used as an indication of purity. Tensile tests were performed to choose crystal orientations suitable for annealing studies. Irradiations were performed to fluences of 8×10^{17} to 3.1×10^{19} nvt. Flow curves are shown for samples before and after irradiation. Activation volumes were determined and found to be about the same before and after irradiation. Samples receiving a fluence of 2.5×10^{19} were tested in tension, and a yield point was observed that had not occurred in previous nonirradiated tests. Two samples were strained small increments with isochronal anneals. At 372 and 403°C, an increase in flow stress (thermal hardening) was observed. Electrical resistivity ratio determinations at room temperature and 4.2°K were used as a measure of specimen purity and also to determine the effects of irradiation and subsequent annealing. The resistivity ratio is shown to be a function of pressure during zone refining. Isochronal anneals on irradiated samples revealed three annealing peaks. The Stage III peak is shifted to lower temperature with increasing fluence while the 700°C and Stage IV peak are not affected. Second-order kinetics were observed around 350°C. The activation energies determined from tensile tests and from resistivity measurements are in agreement in this region. The 700°C annealing peak not observed elsewhere may be due to the extreme purity of the samples. (auth)

17105 (GA-7978, pp 83-94) HIGH STRESS AMPLITUDE DEPENDENCE. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

A niobium sample of sufficient purity was deformed at room temperature about 4% in torsion. Expressions for modulus defect and dislocation strain are derived in terms of experimentally measured quantities. All measurements were made in an inverted torsion pendulum at a frequency of approximately 2 Hz. All operations such as deformation, pinning, and internal friction and modulus determinations were carried out with the specimen undisturbed. (J.C.W.)

17106 (GA-7978, pp 95-117) A NEW METHOD OF MEASUREMENT OF THE PLASTIC PROPERTIES OF RELATIVELY BRITTLE METALS. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

A new nondestructive method of measuring the pre-yield plastic properties of relatively brittle metals is described. The method of measurement consists of exciting torsional resonant oscillations of a thin rod-shaped specimen (usually at frequencies of 1 to 10 Hz) and accurately measuring the dependence of the resonant frequency and internal friction on the maximum oscillating stress amplitude. The relation of the various dislocation relaxations to pre-yield microflow in Nb and Ta were studied. (J.C.W.)

17107 (GA-7978, pp 119-23) THERMALLY ACTIVATED DISLOCATION RELAXATIONS IN FCC AND BCC TRANSITION METALS. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

A mechanical-relaxation spectrum of a well-annealed single crystal of high-purity body-centered cubic crystal of tantalum is graphically presented. The internal friction of the specimen measured by means of the power required to maintain steady-state torsional oscillations at nearly 1 Hz at the various indicated amplitudes is plotted against the temperature of the measurement. The relation between the existence of two relaxations and the flow-stress versus temperature curves for Fe, Mo, W, Nb, and Ta is graphically shown. (J.C.W.)

17108 (GA-7978, pp 143-9) CORRELATION OF STRAIN RELEASE MEASUREMENTS WITH TESTS OF THE DUCTILE-TO-BRITTLE TRANSITION. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The general method used to correlate strain release measurements with tests of ductile-to-brittle transition in quasi-brittle materials such as tungsten, molybdenum, and high-carbon steel is described. The state of knowledge of the theory is summarized. Tungsten is used to illustrate how the transition temperatures, as measured in slow tensile tests and impact tests, may be predicted from the thermal activation parameters derived from strain release measurements. (J.C.W.)

17109 (GA-7978, pp 151-3) TEST METHODS. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

Dynamic internal friction measurements on tantalum were made in an inverted torsion pendulum, which oscillated the sample at a desired amplitude. The power necessary to maintain the cyclic oscillations is a measure of the internal friction and is calculated on an absolute basis by determining the specimen damping in the free decay mode. (J.C.W.)

17110 (GA-7978, pp 155-61) STRAIN RELEASE METHOD. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

A pure metal sample is taken to a low temperature, and a shear stress is applied and maintained constant. The resulting strain is recorded. As each activation temperature is reached, the specimen strain shows a release. A mathematical analysis is presented and a graph showing the activation energy of niobium data is included. (J.C.W.)

17111 (GA-7978, pp 163-72) STRAIN RELEASE TEST INSTRUMENT. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

An instrument design for the measurement of the γ relaxation process in bcc transition metals is described. A thin wire sample of the metal may be used in the apparatus. (J.C.W.)

17112 (GA-7978, pp 173-7) STRAIN RELEASE DATA. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The strain release method has been applied to niobium. The dislocation strain is plotted against the specimen temperature with stress bias as a parameter. An experiment on niobium showed that the γ relaxation is associated with long-range dislocation motion required to initiate plastic flow. Strain-release measurements for Fe, Nb, Ta, and W are shown. (J.C.W.)

17113 (JAERI-1144) PROCEEDINGS OF THE SEMINAR ON PHYSICAL PROPERTIES OF FAST REACTOR FUELS. (Japan Atomic Energy Research Inst., Tokyo). Apr. 1967. 52p. (In Japanese). Dep.

The design of fast reactor fuels, physical properties of oxide and carbide fuels, general ceramics, and the fabrication of ceramic fuels are discussed. (J.C.W.)

17114 (NP-17279) CAVITATION PHENOMENA IN LIQUID METALS. Report No. 01357-1-T. Hammitt, F. G. (Michigan

Univ., Ann Arbor. Lab. for Fluid Flow and Heat Transport Phenomena). Dec. 1967. 13p. Dep.

Aspects of cavitation in liquid metals are reviewed, including the various applications. Cavitation and related phenomena are of importance in sodium-cooled fast neutron breeder reactors, and the problems involved are discussed. Detailed theoretical considerations wherein reactor temperature sodium might be expected to differ from ambient temperature water are reviewed, and the relatively scattered applicable engineering results from component tests which have been published are considered. (auth)

17115 (NYO-2394-31) A COMBINED MACROSCOPIC AND MICROSCOPIC APPROACH TO THE MECHANICAL PROPERTIES OF METALS. Technical Progress Report, February 1967–January 1968. Drucker, D. C.; Gurland, J.; Armstrong, R. W.; Rice, J.; Richman, M. H. (Brown Univ., Providence, R. I. Div. of Engineering). Contract AT(30-1)-2394. 10p. Dep. CFSTI.

The strength and fracture of spheroidized carbon steel regarded as a model for one type of z-phase alloy was studied. The hardness-grain size relation of brass was correlated with the Hall–Petch stress-grain size parameters. Work continued on the mechanism of particle strengthening in cast Al–Si alloys, on the fracture mechanism of Co–WC alloys, and on plastic deformation accompanying a cleavage crack in zinc. Macroscopic fundamentals in brittle fractures, and the role of voids in ductile fracture studies are being continued. (F.S.)

17116 (ORO-3401-3) THE EFFECTS OF SURFACE COATINGS ON THE PLASTIC DEFORMATION OF METAL SINGLE CRYSTALS. Progress Report, May 15, 1967–February 15, 1968. Block, Robert Jay (Oklahoma Univ. Research Inst., Norman). Feb. 15, 1968. Contract AT(40-1)-3401. 72p. Dep. CFSTI.

The strengthening effects produced by various metallic coatings on copper single crystals were studied. There was no relation between the magnitude of the strengthening produced and the mechanical strength of the various coatings. On this basis, a mechanism involving the operation of the coating as a simple barrier to dislocation egress from the crystal was considered inappropriate. Likewise, there was no relation between the relative shear moduli of coating and substrate and the strengthening produced. Thus, the elastic repulsion of dislocations from the coating-substrate interface was also considered to be unimportant as a mechanism. None of the results suggested that the suppression of surface Frank–Read sources made an important contribution to the strengthening effect. Significant film strengthening effects were always accompanied by cracking of the coating either prior to or during deformation. An increase in dislocation density at the substrate surface was associated with film cracking. This surface damage which resulted from residual stresses in the coating is believed to be an important factor in producing the film strengthening effects which were observed. (auth)

17117 (RISO-48(Suppl.3)) BIBLIOGRAPHY ON DISPERSION-STRENGTHENED MATERIALS, 1965. Supplement No. 3. Lilholt, Hans; Jensen, J. C. Balling; Jensen, Ulla (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug. 1967. 88p. Dep.

The annotated bibliography consists of 445 references to available literature on dispersion-strengthened materials and related problems, covering the year 1965. (auth)

17118 NIOBIUM-BASE ALLOYS AND THEIR PROPERTIES. Savitskii, E. M.; Baron, V. V.; Ivanova, K. N. At. Energ. (USSR), 23: 32-7(July 1967). (In Russian).

Niobium alloys containing up to 10% W, 5% Mo, and 1 to 1.5% Zr or Ti were prepared and their impact or continuous stability at 1000 to 1800°C and temperature of recrystallization were determined. The weldability and corrosion resistance of the alloys in lithium at 1000°C and in hydrochloric and sulfuric acids were investigated. Their specific electric conductivity, thermal conductivity factors, linear expansion, and blackness were also studied. The highest thermal resistance was exhibited by niobium-base alloys with tungsten, molybdenum, and zirconium. Their short-duration stability at 1200°C was 18 to 29 kg/mm^2 and at 1500°C 14 to 17 kg/mm^2. Stability duration at 1000°C and σ = 25 kg/mm^2 was 300 to 400 hr. Stability of the Pm-6 niobium alloy at 1200°C for 100 hr was 11 kg/mm^2. The alloys with zirconium had a high corrosion resistance in lithium at 1000°C and in hydrochloric acid at 100°C. (R.V.J.)

17119 RELATION BETWEEN VACANCY FORMATION AND MIGRATION ENERGIES AS WELL AS THE ACTIVATION ENERGY OF THE DIFFUSION AND DEBYE TEMPERATURE OF METALS. Neumann, G. M. (Osram-Studiengesellschaft, Augsburg). Z. Phys. Chem. (Frankfurt), 56: 342-51(Dec. 1967). (In German).

It is demonstrated that there are certain relations between the Debye temperature and the energies of formation and migration of vacancies and the diffusion energy in metals that enable the calculation of these energies with an error of 10%. (auth)

17120 PRELIMINARY OBSERVATIONS ON THE FATIGUE OF HYDRIDED AND UNHYDRIDED ZIRCALOY-2 AT ROOM TEMPERATURE. Wanhill, R. J. H.; Ryder, D. A.; Davies, T. J. (Manchester Univ., Eng.). J. Inst. Metals, 96: 59-60 (Feb. 1968).

Metallographic studies are reported on the fatigue characteristics of 20% cold-worked Zircaloy-2 pressure tubing. Electropolished specimens were tested in fluctuating tension. Primary fatigue failure in unhydrided specimens always occurred from a point on the central cross-section. While secondary cracks were identified at various sites, all cracks except intergranular fissures were smaller than the grain diameter. In hydrided specimens the initial crack was associated with a hydride particle. (UK)

17121 DIFFUSION OF ALKALI METAL IMPURITIES IN SODIUM AND POTASSIUM. Barr, L. W.; Mundy, J. N.; Smith, F. A. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 16: 1139-46(Dec. 1967).

The diffusion of ^{42}K and ^{86}Rb in sodium and ^{22}Na in potassium was measured between 0°C and the melting points. The diffusion coefficients are given by the following equations, where the activation energies are in kcal mol^{-1}: $D(^{42}K) = 0.08 \pm 0.018 \exp(-8.43 \pm 0.14/RT)$ cm^2 sec^{-1}, $D(^{86}Rb) = 0.15 \pm 0.04 \exp(-8.49 \pm 0.15/RT)$ cm^2 sec^{-1}, and $D(^{22}Na) = 0.058 \pm 0.016 \exp(-7.45 \pm 0.17/RT)$ cm^2 sec^{-1}. Reasons are given for believing that diffusion is by vacancies. The results are discussed in terms of (Phil. Mag., 7, 141, 1962, and Ibid., 10, 641, 1964), screened electrostatic and (Acta Metall. S, 443, 1957), elastic interaction theory of impurity diffusion. Some anomalous results obtained close to the mp in K containing ~1 at. % Na are interpreted as being due to diffusion in molten regions of the specimen. (auth) (UK)

17122 HELIUM EMBRITTLEMENT IN TYPE 304 STAINLESS STEEL. Kramer, D.; Brager, H. R.; Rhodes, C. G.; Pard, A. G. (Atomics International, Canoga Park, Calif.). J. Nucl. Mater., 25: 121-31(Feb. 1968).

Helium was uniformly injected into small tensile samples of type 304 (austenitic) stainless steel to concentrations of 1×10^{-7} and 3×10^{-6} atom fraction helium. Subsequent tensile testing above 540°C revealed progressive ductility loss—as measured by total elongation at rupture—with increasing temperature. This effect was more severe in samples with the high helium content where elongations of 760°C were a third or less of those of control samples. Yield and tensile strengths remained unaltered by the presence of helium. Above 650°C, grain boundary sliding, which results in intergranular cracking, becomes important. The cracks begin as voids on carbide particles which act as obstacles to grain boundary sliding. In the presence of helium, bubbles attach themselves to these carbide particles and serve as void nuclei, thereby accelerating the process. Bubbles were also more prevalent on grain boundaries, dislocations and inclusion particles than isolated in the matrix. (auth)

17123 PROTECTION OF ZIRCONIUM AGAINST OXIDATION BY MEANS OF METAL COATING. Baque, P.; Darras, R.; Lafon, A.; Loriers, H. (CEN, Saclay, France). J. Nucl. Mater., 25: 166-71(Feb. 1968). (In French).

A protective coating has been developed on zirconium and its alloys. It is made of chromium deposited either by thermal evaporation or by electrolysis; a thermal treatment is applied, giving rise to a thin layer of $ZrCr_2$ close to the body, which makes the coating adherent. During a long exposure in carbon dioxide, even under pressure, up to 650°C at least, oxidation is then limited to the growing of a thin impervious film of chromium oxide, which replaces the usual scale of little protective zirconia. Oxygen diffusion in the adjacent body is completely inhibited. The latter property of the coating is explained by its particular composition, which is distinguished by the definite presence of a continuous layer of free chromium on the intermetallic compound. (auth)

17124 THERMOCOUPLES FOR HIGH TEMPERATURE MEASUREMENT. Wasan, V. P.; Gupta, C. L. Engelhard Ind., Tech. Bull., 8: 77-92(Dec. 1967).

Efforts have been made in recent years to adopt new materials for use in thermocouples to extend their application to higher temperatures. A brief view of available materials and factors affecting their use in various atmospheres is given. Detailed data on various materials have been included in order to assist in the selection of materials for specified applications. (auth)

17125 DUCTILITY OF MOLYBDENUM SHEETS AT VARIOUS DEFORMATION RATES. Shcheglov, B. A.; Mutovin, V. D.;

Grushevskii, A. V. Kuznechno-Shtampovochnoe Proizvod., No. 2, 18-19(1967). (In Russian).

A series of experiments was conducted to determine the effect of strain rate on the ductility and strength of molybdenum specimens hot- and cold-rolled from a thickness of 5 mm to that of 0.5 mm, vacuum annealed for 1 hr either at 1250°C (recrystallization annealing) or at 850°C, slowly cooled, and subjected to tensile tests at various strain rates. It was found that specimens annealed at 1250°C and strained at a rate of $1.7 \cdot 10^{-5}$ m/sec had an elongation of 29% and a tensile strength of 49 kg/mm^2, while those annealed at 850°C had an elongation of 9% and a strength of 83 kg/mm^2. With an increasing strain rate the elongation of the recrystallized specimens dropped rapidly. At a strain rate of 0.3 m/sec the recrystallized specimens failed with nil elongation, while the specimens annealed at 850°C had an elongation of 5% at a strain rate of 1.82 m/sec. The effect of strain rate on the tensile strength was insignificant. These findings show that forming of molybdenum parts without preheating should be performed at the lowest possible rate. (ATD)

17126 MECHANICAL PROPERTIES AND STRUCTURE OF METAL–CERAMIC SHEET MOLYBDENUM FOR DEEP DRAWING. Mutovin, V. D.; Osipov, V. G. Kuznechno-Shtampovochnoe Proizvod., No. 9, 24-5(Sept. 1966). (In Russian).

Tensile strength, elongation and hardness of sheet Mo were determined in relation to annealing temperatures (800 to 1600°C). Tensile strength and hardness increase linearly with annealing temperature; however, relative elongation increases up to 1300°C, then drops sharply. A drop in plasticity at 1400°C and above corresponds to the development of agglomerate recrystallizations, grain growth and impurity conglomeration on the grain boundaries. Primary recrystallization begins at 1000°C and ends completely at 1300°C. For deep drawing on crank presses at the rate of 0.5 to 0.8 m/sec, the Mo should be annealed at temperatures below recrystallization. (Rev. Metal Lit.)

17127 THE PROPERTIES OF ZIRCONIUM ALLOYS AS CONSTRUCTION MATERIALS IN NUCLEAR REACTORS. PART III. Wiedemann, K. H. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Metall, 22: 38-42(Jan. 1968). (In German).

The creep behavior, effect of radiation on the mechanical stability and corrosion, and heat conductivity of zirconium dioxide are discussed. 60 references. (J.S.R.)

17128 CRITICAL MAGNETIC FIELDS OF ALLOY OF THE NIOBIUM–TITANIUM–ZIRCONIUM SYSTEM. Alekseevskii, N. E.; Ivanov, O. S.; Raevskii, I. I.; Stepanov, N. V. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR, 176: 305-7 (Sept. 11, 1967). (In Russian).

Alloys of the niobium-zirconium-titanium system are semiconductors with high critical parameters. These alloys were studied by determining their critical magnetic field values (H_{cr}). The tests specimens were prepared by melting the pure materials in an electric furnace in argon atmosphere heat treating the castings. Wires with a diameter of 0.3 mm and length up to 170 mm were used for testing after annealing them at 550°C. The critical magnetic field measurements were carried out by the impulse method. The results were plotted as a function of the zirconium concentration for 3 sections of the system: the binary Nb + 45.4 at. % Ti, and Nb + 30 at. % Zr, comparing them with earlier data. The much higher H_{cr} values obtained are attributed to the possible action of oxygen during the arc melting process. (TTT)

17129 BEHAVIOR OF Gd_2O_3 DISPERSIONS IN UO_2 AT HIGH TEMPERATURE. Kubota, Tadashi; Takahashi, Shuichiro (Mitsubishi Atomic Power Industries, Inc., Omiya, Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 37-8(Jan. 1968).

The compatibility of Gd_2O_3 with UO_2 was studied at a temperature near the melting point of UO_2. Massive grains were formed in the central high temperature range above 1800 to 1900°C and the original shape of the Gd_2O_3 was destroyed. Solid solution between Gd_2O_3 and UO_2 formed which did not affect the pore structure. Circular precipitates were observed in the grain boundaries. (F.S.)

17130 MECHANISM OF AGE HARDENING IN ELGILOY. Henmi, Zenzo; Okada, Masanori; Nagai, Takeshi (Fujitsu Labs., Kawasaki, Japan). Nippon Kinzoku Gakkaishi, 31: 1351-5(1967). (In Japanese).

Elgiloy was studied by means of tensile strength, spring limit, hardness and thermal expansion coefficient measurement, x-ray diffraction, and optical and transmission electron microscope observations. The mechanism of age hardening in Elgiloy was not explained by optical microscopic observation, thermal expansion coefficient measurement, and x-ray diffraction. By transmission electron microscopy and electron diffraction it was found that Elgiloy subjected to rolling and annealing, precipitated fine α–Co particles and suggested that the precipitation causes hardening and an increase of the spring limit. (auth)

17131 AN EVALUATION OF COATED B66 COLUMBIAN ALLOY AT ELEVATED TEMPERATURES. Weiss, R. O.; Hill, M. L.; Keller, C. A. (Johns Hopkins Univ., Silver Spring, Md.). J. Spacecraft Rockets, 5: 215-16(Feb. 1968).

A slurry coating consisting of Si-20 Cr-5Ti was evaluated for use on B66 niobium alloy. Results are given for creep at 2379 to 3022°F at stress levels between 2450 and 30,200 psi. Increasing the temperature by 600° from 2379°F decreased the creep strength of the Nb alloy by a factor of 5. The coating provided a protective barrier against oxidation at all temperatures and load conditions investigated. Although a reduction in high temperature ductility was observed in the coated material, the coating provided oxidation protection for high temperature structures for service temperatures as high as 3000°F. (F.S.)

17132 AN ELECTRON MICROSCOPY STUDY OF THE STRUCTURE OF QUENCHED Ti–6 PERCENT Mo ALLOY. Oka, Muneo (Osaka Univ.). Trans. Jap. Inst. Metals, 8: 215-20(Oct. 1967).

The sub-structure of martensite in a quenched Ti–6 wt % Mo alloy has been investigated by means of transmission electron microscopy; microhardness and x-ray measurements have also been made. It was found that in x-ray and electron diffraction patterns of the quenched specimens, there were spots due to the α'-phase (hcp), but no spots due to the β-phase (bcc) or ω'-phase (hexagonal) were observed; in the quenched specimens, needle-shaped markings in the optical micrographs were a banded martensite (α'-phase) and a large number of small lenticular martensite plates, which occupied the greater part of the specimen, were between the banded martensite plates; lattice defects in the banded martensite were $\{10\bar{1}1\}$ transformation twins and dislocations on (0001) planes with two kinds of the banded martensite, one contained dislocations and the other dislocations and transformation twins with the latter more frequently occurring than the former; and the lattice parameters of the martensite in Ti–6% Mo alloy were $a = 2.92_8$, $c = 4.66_3$, $c/a = 1.59_3$. (auth)

17133 SULFUR DIFFUSION IN NIOBIUM. Vandyshev, B. A.; Panov, A. S. Izv. Akad. Nauk SSSR, Metal., No. 1, 206-9(Jan.-Feb. 1968). (In Russian).

Radioactive ^{35}S was used for determining sulfur diffusion into mono- and polycrystalline niobium at 1370 to 1170°K. The temperature dependence of sulfur diffusion into monocrystalline niobium was $D = 2.6 \times 10^3 \exp(-73{,}100/RT)$, cm^2/sec. Data obtained for sulfur diffusion into large-grain polycrystalline and monocrystalline niobium did not indicate any difference. Autoradiograms of polycrystalline niobium showed sulfur distribution preeminently along the grain boundaries. (R.V.J.)

17134 NICKEL DIFFUSION IN Ni–Nb ALLOYS. Shinyaev, A. Ya. Izv. Akad. Nauk SSSR, Metal., No. 1, 203-5(Jan.-Feb. 1968). (In Russian).

A radioactive isotope, ^{63}Ni electrolytically deposited on Nb–Ni alloy specimens at a thickness of 1μ was used for determining Ni diffusion in alloys containing up to 10 wt % Nb. The diffusion was studied at 1230, 1198, 1100, and 1036°C with annealing times from 4 to 120 hr, respectively. Graphic data are given of the influence of Ni–Nb content and temperature on the nickel and Fe inpurity diffusion coefficients. (R.V.J.)

17135 RHENIUM DIFFUSION IN TUNGSTEN. Zelikman, A. N.; Kotlyar, A. A.; Kuznetsov, Yu. G. Izv. Akad. Nauk SSSR, Metal., No. 1, 197-202(Jan.-Feb. 1968). (In Russian).

Electric conductivity method was used for determining coefficients of 60 wt % rhenium (σ phase) diffusion into tungsten at 1400, 1625, 1850, and 2000°C. The order of error of determination is ±22%. The temperature dependence of rhenium diffusion in tungsten at above conditions is $D = 1.2 \times 10^{-6} \exp(-29900/RT)$ cm^2/sec where 29900 kal/g-atom is the energy of activation process. The order of error in determination of the energy is ±15%. (R.V.J.)

17136 SILICON DIFFUSION IN ZIRCONIUM AND ALUMINUM. Drits, M. E.; Kadaner, E. S.; Kuz'mina, V. I. Izv. Akad. Nauk SSSR, Metal., No. 1, 170-5(Jan.-Feb. 1968). (In Russian).

Microstructure analysis and electrical resistance measurements used for determining the silicon diffusion into Al and Zr showed that at 565, 525, 500, and 400°C the silicon diffusion into Al is 1.3, 1.0, 0.75 and 0.25 wt % and in Zr at temperatures of 620, 525, 500, and 400°C it is 0.2, 0.11, 0.0875, and 0.06 wt %. (R.V.J.)

Structure and Phase Studies

17137 (GA–7978, pp 61-81) GENERAL INTRODUCTION AND EXAMINATION OF DISLOCATION INTERACTIONS. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

A new dislocation motion model was developed and used to explain the oscillating-stress amplitude-dependent internal friction and modulus of very-high-purity bcc transition metals. (J.C.W.)

17138 (GA–7978, pp 125-32) DISLOCATION PINNING IN NIOBIUM. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

A high-purity niobium monocrystal was prepared with a room-temperature to 9°K-resistivity ratio of >450. The sample was tested at deformation of 0.5% at 150°K. The internal friction spectrum plotted as a function of temperature with various annealing states as parameter is presented. A deformation at 1.8% in torsion at room temperature was performed. The dislocation spectra show that low temperature anneals can be used to immobilize dislocations by pinning. (J.C.W.)

17139 (GA–7978, pp 133-41) INVESTIGATION OF THE INFLUENCE OF POINT DEFECTS INTRODUCED BY IRRADIATION ON THE MOBILITY OF DISLOCATIONS IN THE BCC TRANSITION METALS. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The results of the high oscillating-stress-amplitude experiments are summarized. Only when the maximum oscillating stress amplitude reached the stress necessary to stress-assist the γ relaxation process did the details of the amplitude-dependent curves change; the stress-microstrain loops were reproducible as long as the maximum stress reached on a cycle did not exceed the stress necessary to move dislocation segments that are associated with the γ relaxation processes. If a specimen had received an anneal prior to high-amplitude measurement (an anneal that was sufficient to show considerable reduction in the height of the γ relaxation as measured at low amplitudes), then the maximum stress required to disturb the amplitude-dependent curve (or equivalently the details of the stress-microstrain loops) was higher. This result is equivalent to the usual observation made by standard testing methods that the initial flow stress (0.01% offset) is increased by impurities (or point defect pinning generally). It is generally observed that the additional increase in flow stress caused by the addition of impurities is not independent of the temperature of measurement of the flow stress. The increment to the flow stress decreases with decreasing temperature, opposite to what would be expected if the pinning process simply added an additional stress to the intrinsic stress required to move dislocations. The addition of impurities appears to increase the effective activation energy of the rate-controlling process. A model is given that is consistent with the observations. (J.C.W.)

17140 THERMOCHEMICAL AND TECHNOLOGICAL INVESTIGATIONS ON THE URANIUM MONONITRIDE–CARBON SYSTEM. Ondracek, G. (Kernforschungszentrum, Karlsruhe, Ger.); Petzow, G. J. Nucl. Mater., 25: 132-43(Feb. 1968). (In German).

In preparing uranium mononitride compacts, the concentrations and temperature at which uranium carbonitride is in equilibrium with carbon and uranium dicarbide, and temperatures and corresponding nitrogen partial pressures at which a UC_xN_{1-x} phase of given concentration decomposes in its components or takes up further nitrogen under simultaneous depletion of carbon are determined and studied thermochemically. As results, the stability ranges are plotted versus temperature, concentration and nitrogen pressure, respectively. Furthermore, the liquidus and solidus in the system UC – UN are estimated. Based on these considerations, preparation conditions are determined for dense compacts (≈ 90% TD) by hot-pressing: 1700°C; $10^{-8}-10^{-4}$ torr nitrogen pressure; 420 Mp/cm^2 pressure. In this way, samples in the concentration range between carbon and uranium mononitride were prepared and examined by density measurements as well as x-ray and metallographic methods. (auth)

17141 EXTENDED DISLOCATIONS AND STACKING FAULTS ON {110} AND (001) PLANES OF α-URANIUM. Saxl, I.; Kocik, J.; Otruba, J. (Nuclear Research Inst., Rez, Czech.). J. Nuclear Mater., 25: 172-8(Feb. 1968).

The possibility of the existence of stacking faults in the {110} plane in α-uranium has been investigated. Different stacking faults introduced by insertion or removal of a plane or by a partial slip are described at length. The conditions of stability against further dissociation for all perfect and imperfect dislocations considered here are derived, using both anisotropic and isotropic elasticity theory. For the extended dislocation the equilibrium width of a stacking fault is calculated in terms of the stacking fault energy. The calculations have been carried out for dissociations of dislocations in the {110} as well as in the (001) planes. The maximum stacking fault energy that would allow the corresponding dissociations is also evaluated. Under certain assumptions the temperature dependence of the equilibrium width of an extended dislocation has also been estimated. (auth)

17142 THORIUM–THORIUM MONOARSENIDE PHASE EQUILIBRIA. Benz, R. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 25: 233-5(Feb. 1968).

The boundaries of the face-centered cubic ThAs phase with the lattice parameter of 5.972 Å are reported. Preparations with various As/Th ratios up to 1.1 were made by reacting thorium powder, obtained from crystal-bar thorium, with arsenic in a heated silica tube. The reacted powders were pressed into cylinders 6 mm in dia and 13 mm long and sintered in vacuo. (J.C.W.)

17143 STUDY OF THE METASTABLE PHASE OBTAINED BY TEMPERING THE Zr–2.4 WT PERCENT Cu ALLOY. Couterne, Annick; Cizeron, Georges (CEN, Saclay, France. Centre de Recherches Metallurgiques de l'Ecole des Mines, Paris). Compt. Rend., Ser. C, 266: 254-7(Jan. 22, 1968). (In French).

High-temperature tempering of the alloy Zr – 2.4 wt % Cu produces a submicroscopic phase, ω, with hexagonal structure and the parameters a = 5.03 Å and c = 3.14 Å. This phase is decomposed by isothermal or nonisothermal tempering at a temperature below 500°C to give first a solid solution, α, supersaturated with Cu and then the equilibrium solid solution α and the compound Zr_2Cu. (tr-auth)

17144 CONSTITUTION DIAGRAM OF Zr–Ta–V SYSTEM. Tararaeva, E. M.; Ivanov, O. S. Izv. Akad. Nauk SSSR, Metal., No. 1, 181-91(Jan.-Feb. 1968). (In Russian).

Microscopic and x-ray analyses and hardness and microhardness measurements were used for constructing the isothermal cross sections of the constitution diagram of Zr – Ta – V at 750 to 1350°C. The maximum solubility of components in solid solutions with tantalum, vanadium, β-zirconium and α-zirconium base was found for each cross section. The general phase diagram constructed for the Zr – Ta – V system can be used as a starting point for any arbitrary alloy of the Zr – Ta – V system. (R.V.J.)

17145 CONSTITUTION DIAGRAM OF THE MOLYBDENUM ENRICHED Mo–Ti–C SYSTEM. Zakharov, A. M.; Savitskii, E. M. Izv. Akad. Nauk SSSR, Metal., No. 1, 162-9(Jan.-Feb. 1968). (In Russian).

Microscopic, structural and x-ray analyses were made for determining the temperature of initial melting and microhardness of the Mo angle of the ternary Mo – Ti – C system with 0 to 0.5 wt % C and 0 to 7 wt % Ti. The isotherms of the surface of the liquidus were constructed at 1970 and 1250°C. The temperature of the eutectic melting $\alpha + Mo_2C$ in the binary Mo – C system is equal to 2510 ± 20°C. The Mo – TiC cross section in the ternary Mo – Ti – C system is of quasibinary character and has a eutectic type diagram at 2290 ± 20°C. (R.V.J.)

Radiation Effects

Refer also to abstract 17082.

17146 (HPR–91) EVALUATION OF THE IRRADIATION DAMAGE IN THE HBWR PRESSURE VESSEL MATERIALS. Hanevik, Amund; Videm, Ketil (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Nov. 1967. 37p. Dep.

The irradiation induced changes in impact properties of the mild steel components in the Halden Boiling Water Reactor (HBWR) pressure vessel have been investigated by irradiation of Charpy V-notch specimens both at ORNL and in the HBWR. The results indicate that the compound plate in the vessel wall is more irradiation sensitive than the flange, lid or weld materials. The neutron spectrum in the HBWR has been calculated by three different computer codes. For specimens irradiated near the vessel wall better correlations between neutron dose and damage is found by use of a multigroup treatment rather than by a simple square root law which takes into consideration only neutrons with energies above 1 MeV. Assessment of the transition temperatures in the vessel itself after the second and third charge operations of the reactor is based on the established correlations. Safety against brittle fracture is at present secured by keeping the vessel above Nil Ductility Temperature (NDT) + 60°F during shutdown conditions because of unknown residual stresses. These stresses have been assessed for the cylindrical part of the vessel, which has the highest transition temperature and is thus the determining factor. This assessment indicates that the stress level is about 8 kg/mm^2 in the unpressurized condition, or about 25% of the room temperature yield strength. This forms the basis for a suggested change in the brittle fracture hazard's criterion to Crack Arrest Temperature (CAT) + 10°C. (auth)

17147 (NRL–6649) TENSILE PROPERTIES OF SELECTED STEELS FOR USE IN NUCLEAR REACTOR PRESSURE VESSELS.

Klier, Eugene P.; Hawthorne, J. R.; Steele, Lendell E. (Naval Research Lab., Washington, D. C.). Sept. 22, 1967. Contract AT(49-5)-2110. 52p. Dep. CFSTI.

Seven steels now used or having potential for use in the construction of nuclear reactor containment vessels were evaluated in uniaxial tension at 75°F following irradiation at <250°F. Experiment irradiations involved neutron fluences up to 9.5×10^{19} n/cm^2 (>1 Mev). Tensile properties of the A212-B, A302-B, A350-LF1 (Modified), A350-LF3, A353, T-1, and HY-80 (Ni–Cr–Mo) steels were determined as conventional tensile and yield strength and percent reduction of area. In addition, observed stress-strain relationships were plotted using both nominal stress-percent reduction of area coordinates and true stress-natural strain coordinates. Curves given in the latter coordinate system were also expressed in suitable analytic form. All individual tensile data were compiled in tabular form, and stress-strain curves were summarized as bands giving maximum and minimum properties behavior. Limited metallographic and fractographic data were obtained to establish the metallurgical structures of the steels and to depict the transition from a ductile shear fracture to a brittle flat fracture at high neutron fluences for the more brittle steels. (auth)

17148 (ORNL-TM-2138) SEVERE RADIATION DAMAGE TO ALUMINUM ALLOYS. Cunningham, J. E. (comp.) (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 52p. Dep. CFSTI.

Malfunction of core components in the Oak Ridge Research Reactor owing to excessive bowing and the unexpected failure of transuranium target rods that leaked radioactivity into the coolant system of the High Flux Isotope Reactor have been traced to severe radiation damage to aluminum alloys. The gross structural damage observed is accompanied by drastic alteration of mechanical properties and the formation of about 10^{15} cavities/cm^3. The cavities give rise to swelling in the material. Pre- and postirradiation data that delineate radiation embrittlement and a striking loss in total strain before fracture on 1100, 6061-T6, and X8001 aluminum alloys are presented and discussed. Preliminary results on the influence of cyclotron-injected helium to a level of 5 at. ppM on the mechanical behavior of the same alloys in the annealed condition and hot-rolled SAP 895 are described and compared with effects induced by reactor irradiation. Potential damage mechanisms are reviewed, and the need for further study under well-controlled and analyzable conditions is stressed. (auth)

17149 (AD–662789) SOFTENING OF CAST IRON BY IRRADIATION WITH NEUTRONS. Markovskii, E. A.; Krasnoshchekov, M. M. Translated by F. Dion from Liteinoe Proizvod., No. 6, 32(1966). 6p. (FTD-HT–23-549-67; TP–7000963). CFSTI.

Groups of specimens of malleable cast iron, annealed for 34 hr at 970°C, were exposed to integral fluxes of 10^{16}, 10^{17}, 10^{18}, 10^{19}, and 10^{20} neutrons/cm^2 in a water-moderated water-cooled reactor. Before and after the irradiation the specimens were tested for linear wear W, friction coefficient μ and temperature t of the lubricant emerging from the friction zone. Vickers hardness and microhardness were also tested. The wear tests showed that W, μ and t are hardly affected by irradiation. W increases markedly in the presence of 10^{18} neutrons/cm^3, although it eventually again returns to normal. The pattern of variation in the hardness of the irradiated malleable and high-strength cast irons resembles the pattern of variation in their wear resistance. Hardness decreases following the irradiation of malleable cast iron with insignificant neutron fluxes (10^{17}–10^{18} neutrons/cm^2) but increases again as the neutron dose is increased. A similar pattern of variation in microhardness is observed. Evidently this is associated with the softening of the pearlitic component, since the hardness of the ferritic component increases monotonically with irradiation. It appears that the softening of annealed cast iron and various steels in the presence of low neutron doses is attributable to defects caused in the crystal lattice of the material by the neutron. As regards cast iron, a definite role is played by the cementite and ferrite grain boundaries, which apparently get weakened by the defects introduced by neutron irradiation, when these defects migrate toward grain boundaries. Thus, irradiation is accompanied by two simultaneous processes: softening of the material due to the weakening of grain boundaries and hardening of the crystal lattice in proportion to the number of the bombarding fast neutrons. As irradiation time increases, the hardening process begins to predominate. (auth)

17150 RADIATION DAMAGE TO MATERIALS. Kriegel, E. (Technische Univ., Berlin). Chem.-Ing.-Tech., 40: 31-6(Jan. 19, 1968). (In German).

In order to estimate in advance the extent of radiation damage to materials, an approximation equation was derived, which was based on energy considerations of the damage process and took into consideration the influence of the experimental conditions and the properties of the material (particularly the hardness, and elasticity modulus), as well as the damage mechanism. For exact data, further experiments are necessary, particularly with materials whose elasticity modulus is situated in the region of greatest damage. (auth)

17151 INFLUENCE OF IRRADIATION ON THE NUCLEATION OF GAS BUBBLES IN REACTOR FUELS. Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 25: 227-32(Feb. 1968).

The atomic collision events resulting from the inherent fission fragment irradiation of nuclear fuels can create a kinetic solubility of inert gas atoms. The life-time of a gas bubble nucleus in an irradiation environment is compared with the time taken for further gas atoms to be captured; in this, both irradiation enhanced and thermal diffusion processes are considered. Using reasonable estimates for the various parameters, it is found that at technologically important gas concentrations bubble nucleation occurs homogeneously through the fuel, and that at low temperatures irradiation-enhanced diffusion is the controlling factor. (auth)

17152 METALLIC FISSION-PRODUCT INCLUSIONS IN IRRADIATED OXIDE FUELS. Bramman, J. I.; Sharpe, R. M.; Thom, D.; Yates, G. (United Kingdom Atomic Energy Authority, Thurso, Scotland). J. Nucl. Mater., 25: 201-15(Feb. 1968).

Evidence is presented in support of the view that white, generally spherical inclusions observed in irradiated oxide fuels are fission product aggregates. Work on inclusions extracted from a uranium–plutonium oxide $(U_{0.85}Pu_{0.15})O_2$ has shown them to consist principally of a molybdenum–ruthenium–technetium–rhodium–palladium alloy with hexagonal crystal structure, containing no detectable fission material. Additionally a hitherto unreported face-centered cubic palladium–uranium–plutonium–rhodium–ruthenium alloy has been identified in a region of an inclusion which has been in contact with the mixed oxide fuel. The evidence indicates that both materials were metallic in nature, electron-probe microanalysis failing to indicate the presence of appreciable amounts of oxygen. It has been estimated for a particular case that no more than 5% of the total volume of inclusions could consist of the palladium-rich fissile-material-bearing phase. Both the observed alloys have been shown to be very resistant to dissolution in acids. (auth)

17153 IRRADIATION BEHAVIOR OF HOLLOW-CORE METALLIC-URANIUM FUEL ELEMENTS. Weber, J. W. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Nucl. Appl., 4: 134-5(Mar. 1968). (BNWL-SA–1484).

Interim results of a continuing test involving irradiation of metallic U fuel elements are discussed. Results of measurements show that each of the 34 elements tested experienced an initial decrease in external volume followed by a reverse in direction of volume change at 2000 MWd/t. At the report time exposure of 6500 MWd/t all elements continued to exhibit external volume less than their preirradiation volume. (J.R.D.)

17154 FORMULATION AND VERIFICATION OF DESIGN CRITERIA FOR ZIRCALOY-2 PRESSURE TUBING. Merckx, K. R. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Nucl. Eng. Design, 6: 440-6(1967). (BNWL-SA–1423).

Results from experimental and surveillance programs for the Zircaloy-2 pressure tubes in the Plutonium Recycle Test Reactor are reviewed. The review of these results shows that the original PRTR design basis was conservative, that a higher working stress and longer tube life can be used in present reactor applications, and that there are no indications of an increased likelihood of catastrophic failure due to normal reactor operations. (auth)

17155 RADIATION-INDUCED VOLUME CHANGES AND ANNEALING IN SiO_2–UO_2 VITRO CERAMICS. Lungu, S.; Ribco, L.; Beleuta, L. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 353-61(1967).

The experimental results on irradiation induced volume changes of UO_2–SiO_2 vitroceramics against the irradiation dose at ordinary temperatures and for given doses at 80 to 940°C and the annealing curves during post-irradiation treatments are reported. An attempt was made to interpret the data by considering the properties of the vitreous phase in the UO_2–SiO_2 system. The diagram of the activation energy versus defect concentration deduced on the basis of these data is also given. (auth)

Ceramics and Cermets

Refer also to abstract 16828.

17156 (BNWL–680, pp 20–4) HYDROLYSIS OF RARE EARTH OXIDES. Fullam, H. T.; Roberts, F. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The dissolution rate of compacted and sintered Pm_2O_3 is slow and the solubility low, but disintegrate rapidly when exposed to water. Pellets of Nd_2O_3, Pm_2O_3, and Sm_2O_3 were prepared by hot pressing and the stability observed when exposed to water. Increasing the water temperature accelerates the rate of disintegration of the oxide pellets. Mixed oxides of phosphates, vanadates, titanates, and tungstates were prepared and their stability measured. The rate of oxide hydrolysis was determined by weight gain as a function of time. (J.C.W.)

17157 (ORNL-4185) ^{144}Ce DATA SHEETS. Rimshaw, S. J.; Ketchen, E. E. (Oak Ridge National Lab., Tenn.). Nov. 1967. Contract W-7405-eng-26. 30p. Dep. CFSTI.

Extensive chemical, physical, and mechanical property data are given for ^{144}Ce in the form of cerous oxide (Ce_2O_3), cerium oxysulfide (Ce_2O_2S), cerium sulfide (Ce_2S_3), and cerous fluoride (CeF_3) Included in the data are: specific activity vs. cooling time; radionuclidic abundance; specific power; radiation properties; density; coefficient of thermal expansion; specific heat; enthalpy; phase transformations; thermal conductivity; thermal diffusivity; mechanical properties; biological tolerances; shielding data; heat of formation; free energy of formation; and entropy. (S.F.L.)

Corrosion and Erosion

17158 METHOD OF INHIBITING THE CORROSION OF GRAPHITE. Goenvec, Herve (to Commissariat a l'Energie Atomique). British Patent 1,091,223. Nov. 15, 1967. Priority date Oct. 26, 1965, France.

A method of inhibiting the corrosion of graphite in graphite-moderated, CO_2-cooled reactors consists in adding to the CO_2 at least one organo-metallic compound that is gaseous at the minimum operating of the CO_2 coolant loop. Preferably, the compound is of the M–R type where M is a metal and R is methyl, ethyl, propyl, or butyl and is present in an amount about 0.2% by weight. (B.L.M.)

Preparation and Fabrication

Refer also to abstract 18046.

17159 (ORNL-4075, pp 38-42) SOL-GEL PROCESS DEVELOPMENT. Haas, P. A. (Oak Ridge National Lab., Tenn.).

Studies of urania sol preparation and of the formation of urania or mixed oxide sols into microspheres were continued. Consistent reduction of uranyl nitrate to uranous nitrate for more than 50 hr of operation was achieved by using a higher H_2 flow rate to agitate the solution and a revised shutdown procedure to prevent precipitation on the catalyst. Additional urania sols were prepared in a precipitation–filtration–peptization vessel. An apparatus for the continuous preparation of urania sols is being installed, and shakedown testing of the apparatus is in progress. Various sols were formed into gel microspheres. (auth)

17160 (ORNL-4075, pp 43-61) THORIUM FUEL CYCLE STUDIES. Haas, P. A. (Oak Ridge National Lab., Tenn.).

The development of equipment and procedures for preparation of oxide microsphere for use in studying other fuel-cycle problems were continued. Since many operating difficulties would be minimized by the attainment of more nearly uniform sol drop sizes, additional sol dispersion devices were tested. The two-fluid nozzles are still the most reliable and controllable dispersion devices. The method involving free fall of drops from orifices is limited to large sol drop sizes and is affected by unexpected changes in interfacial tension. The sol drops formed by capillaries that are mechanically connected to, and vibrated by, a loudspeaker are more uniform than those from any other disperser. The search for more controllable and reliable dispersers will continue. The fluidized-bed water extractor appears to be more suitable for microsphere preparation in the Thorium-Uranium Recycle Facility than equipment without fluidization. The CPDF microsphere system was revised to include a column of greater taper, a new dryer, and a hydraulic system for transferring gel spheres. All of these were tested and were shown to be superior to the units that they replaced. The column was operated for 74 hr over a 2-month period to prepare 86 kg of thoria microspheres. (auth)

17161 (UCRL-17896) R-F PLASMA MICROSPHEROIDIZATION OF CERAMICS. Tremper, Randolph Tilden (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 38p. Dep. CFSTI.

Thesis.

The use of the r-f induction coupled plasma generator for the spheroidization of ceramic powders was studied and an attempt was made to optimize several of the design and operating parameters of the equipment. The most important problem to be overcome was the design of a powder injection nozzle which would give a laminar flow pattern so that accurate placement of the powder in the plasma flame could be accomplished. Attempts were made, with varying degrees of success, to spheroidize SiO_2, NiO, and α-Al_2O_3. (auth)

17162 ALUMINUM IN ATOMIC FUELS. Pollet, M.; Troccon, G. Bull. Belgicatom, 12: Nos. 2-3, 13-15(July-Oct. 1967). (In French).

Al is used as a cladding material for nuclear fuels to be used principally in research reactors with light or heavy water. The constitution, fabrication of the claddings, and the qualities required are briefly reviewed. (J.S.R.)

17163 RELATIONS BETWEEN PROPERTIES OF WC–TiC–TaC–10 PERCENT Co ALLOYS AND CARBON CONTENT. Suzuki, Hisashi; Hayashi, Kozi (Tokyo Univ.). Trans. Jap. Inst. Metals, 8: 253-9(Oct. 1967).

Main properties of various WC–TiC–TaC–10% Co cemented carbides have been investigated relating to the carbon content. Specimens were vacuum-sintered at 1400°C for 1 hr. The carbon contents of the alloys were strictly controlled. Properties such as lattice parameters of γ (binder) and β_t (WC–TiC–TaC triple carbide) phases, hardness, transverse-rupture strength, etc., were measured relating to the carbon content as well as titanium carbide and tantalum carbide contents. The results showed that: the composition of the γ phase and the carbon content of the β_t phase changed regularly according to the variation in the carbon content, as have been observed in WC–Co, WC–TiC–Co, WC–TaC–Co alloys, etc.; the carbon content of the β_t phase nearly attained the stoichiometric value, when the tantalum carbide content in the β_t phase exceeded about 50%; the $(WC + \beta_t + \gamma)$ three-phase region was extended mainly with increasing titanium carbide content; and other properties changed regularly with the carbon content. The most excellent mechanical properties were exhibited in high carbon three-phase alloys, in particular, in the alloys having the β_t phase with the composition of 50 to 60% tantalum carbide. (auth)

17164 INVESTIGATION OF SINTERING CONDITIONS OF ARTICLES MADE OF LANTHANUM HEXABORIDE. Shlyuko, V. Ya.; Chernyak, L. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 12, 41-5(Dec. 1967). (In Russian).

The conditions were investigated for obtaining articles of lanthanum hexaboride by means of sintering compacted blanks in vacuum without fillers and with fillers of lanthanum hexaboride in powder and sintered granule forms. An optimum composition of fillers is determined which enables the production of articles with 99.2% of density. (auth)

17165 PLUTONIUM CARBONITRIDE. Guyton, James L.; Thompson, Milton A. (to United States Atomic Energy Commission). U. S. Patent 3,368,877. Feb. 13, 1968.

A method was developed making plutonium carbonitride from solid plutonium carbide and plutonium metal in which the carbide and metal are nitrided with ammonia and heated to about 1,000°C. Thereafter the mixture is homogenized under vacuum at the above temperature. (AEC)

Properties Evaluations

Refer also to abstracts 16789, 17115, 17124, 17210, 17730, and 17771.

17166 (BNWL-680, pp 19-20) THERMAL DIFFUSIVITY OF $^{147}Pm_2O_3$. Gibby, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The thermal diffusivity measurements of $^{147}Pm_2O_3$ were made at 75 to 1600°C using a laser heat pulse apparatus. The measurements were made as a function of the concentration level of the decay product ^{147}Sm. An increase in ^{147}Sm concentration had no measurable effect on thermal diffusivity in the range investigated. (J.C.W.)

17167 (IS-T-147) INFLUENCE OF PRECIPITATES ON THE BRITTLE-DUCTILE TRANSITION OF CHROMIUM. Tucker, Robert Clark Jr. (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 88p. Dep. CFSTI.

Thesis.

The effects of heat treatment and nitrogen concentration on the brittle-ductile transition temperature and related properties of chromium have been investigated. Aging oil quenched chromium-nitrogen alloys at temperatures below 455°C produces, as a function of aging temperature at any given nitrogen concentration, a decrease in transition temperature, an increase in yield strength, continuous incremental increases in resistance ratios, and a maximum in hardness at about 300°C. The alloys contain small coherent or semicoherent particles, larger incoherent hexagonal $Cr_2N_{\{001\}\alpha}$ precipitates with $\{001\}_\alpha$ habit planes, and, at higher concentrations of nitrogen, hexagonal Cr_2N precipitates of the same structure but with $\{112\}_\alpha$ habit planes. Averaging at 455°C results in the solution of the small particles and precipitation of additional $Cr_2N_{\{001\}\alpha}$. Alloys fully aged at 635°C or above exhibit a minimum in transition temperature at about 300 to 350 ppM and yield strength at about 200 to 250 ppM, and a corresponding maximum in resistance ratios, but no change in hardness values as a function of nitrogen concentration. The alloys contain Cr_2N $Cr_2N_{\{001\}\alpha}$ at all concentrations and $Cr_2N_{\{112\}\alpha}$ at high concentrations of nitrogen. A transient peak in resistance ratios and transition temperatures was found as a function of aging time at low concentrations, but not at high concentrations of nitrogen. Fractographic studies indicated that the minimum in transition temperatures are characterized by extremely rough transgranular cleavage facets with some evidence that precipitates impede the propagation of the crack. A model is proposed to explain some of the aging effects based on the density and morphology of the Cr_2N precipitates formed during quenching and on the precipitation of the nitrogen retained in solution upon quenching as small particles of varying coherency and their subsequent solution and reprecipitation on pre-existing Cr_2N or as new $Cr_2N_{\{001\}\alpha}$ particles. (auth)

17168 (STI/DOC-10/79) THE PLUTONIUM–OXYGEN AND URANIUM–PLUTONIUM–OXYGEN SYSTEMS: A THERMOCHEMICAL ASSESSMENT. Technical Reports Series No. 79. Report of a Panel on Thermodynamics of Plutonium Oxides held in Vienna, 24–28 October 1966. (International Atomic Energy Agency, Vienna (Austria)). 1967. 86p. IAEA: $2.00; Austrian Schillings 52,-; 14/2 stg; F Fr 9,80; DM 8,-.

Structural and thermodynamic data for the Pu – O and U – Pu – O systems are reviewed. Plutonium oxides, the uranium-plutonium-oxygen system, and other $PuO_2 - MeO_x$ oxide systems are discussed. (167 references). (auth)

17169 RELEASE OF XENON FROM SINTERED UO_2 AT LOW TEMPERATURES. Taketani, Kiyoaki; Ikawa, Katsuichi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 589-94(Dec. 1967).

Release of Xe from lightly sintered UO_2 was measured by post-irradiation heating in vacuum at 400 to 300°C. The release rate after the initial burst followed the diffusion model. An Arrhenius plot of the diffusion coefficients revealed a discontinuity at 600°C. Activation energies were calculated to be 3.4 kcal/mol at temperatures lower than the discontinuity, and over 36 kcal/mol in higher temperature range, which corresponded respectively to non-lattice and lattice diffusion. The discontinuity is explained by a changeover of the predominance of one process over another depending on temperature range. The initial burst could not be attributed to surface oxidation. Based on analyses of such factors as dependence of burst on temperature and on specific surface area, as well as percentage of burst release, a kind of activated extrication from superficial layer, approximately 5 Å thick, was proposed as a concept for interpreting the burst phenomenon. (auth)

17170 STRESS DEPENDENCE OF TENSILE CREEP RATE IN CARBONS AND GRAPHITES. Fischbach, D. B. (California Inst. of Tech., Pasadena). Nature (London), 217: 840-1(Mar. 2, 1968).

It is stated that, in principle, studies of the stress dependence of the creep rate offer a simple method of obtaining information as to which of several possible deformation mechanisms operate at high temperatures. Using the empirical relationship $\dot{\epsilon} = A\sigma^n$, where $\dot{\epsilon}$ is creep rate, σ is stress, and $\underline{A}$ is a proportionality constant, the exponent $\underline{n}$ would be expected to be 1 for Nabarro–Herring diffusion mass-transport creep, and a much larger value of $\underline{n}$, typically between 4 and 5, would be expected for an edge dislocation climb mechanism such as occurs in many metals. Reasons are given as to why pyrolytic and glassy carbons are suitable materials for such studies; a careful study of the macroscopic deformation behavior of these materials should give information concerning the important fundamental mechanisms. Results from such a study are described. The pyrolytic carbon employed was deposited at 2,200°C from methane, and had a substrate-nucleated microstructure. The glassy carbon specimens were heat treated at 2,000 or 3,000°C. Neither material showed a minimum or steady state creep rate. A stress change technique was therefore developed to determine the stress dependence for a range of stresses in single tests on single specimens. For pyrolytic carbon no dependence of $\underline{n}$ on stress or temperature was observed. The creep activation energy was about 250 k cal/mole, independent of elongation. This indicates diffusion by a vacancy mechanism parallel to the layer planes. It seems that, in this material, dislocation climb may be important initially, but after breakdown of the as-deposited structure has commenced a viscous process such as Nabarro-Herring creep predominates. The deformation behavior of glassy carbon was quite different. The value of $\underline{n}$ increased approximately linearly with stress, and an activation energy of ~350 k cal/mole was found in the medium stress range. Although Nabarro-Herring creep may be significant in glassy carbon at very low stresses, other mechanisms, of uncertain nature, must operate in the medium and high stress ranges. Dislocation mechanisms seem unlikely. (UK)

17171 FRICTION CHARACTERISTICS OF TUNGSTEN–BORON NITRIDE ALLOYS. Artamonov, A. Ya.; Dzhafarov, Y. A. Porosh. Met., Akad. Nauk Ukr. SSR, No. 12, 78-83(Dec. 1967). (In Russian).

Results obtained in investigating the dry friction of the hard alloy W + BN at various rates of sliding motion and pressures are reported. It was found that the compositions possess a high resistance to attrition. The friction coefficient under the test conditions is reported. (auth)

17172 ELECTROLYTIC HYDROGEN CHARGING IN NIOBIUM SINGLE CRYSTALS. Sasaki, Yasuo; Amano, Muneyuki (National Research Inst. for Metals, Tokyo). Trans. Jap. Inst. Metals, 8: 276-7(Oct. 1967).

The effect of the addition of H by electrolytic charging on the impurity contamination and on the microstructure of Nb – H alloys was studied. It was found that the plate-like hydride in the intermediate region aligns in the same manner as the alloy prepared by gas reactions, and that electrolytic charging is a satisfactory method for introducing H without impurity contamination. (F.S.)

17173 BEHAVIOR OF UO_2–WB_2 AND UO_2–TaB_2 FUELS IN STEAM. Kubota, Tadashi (Mitsubishi Atomic Power Industry, Inc., Saitama, Japan). Trans. Jap. Inst. Metals, 8: 269-75(Oct. 1967).

WB_2 and TaB_2 dispersives in UO_2 were heated in flowing steam and in static high-pressurized steam, and the reaction between steam and borides was studied by means of the x-ray diffraction method and optical microscopy. Results showed that powder compacted specimens of $UO_2 - WB_2$ and $UO_2 - TaB_2$ reacted with the flowing steam at 600°C. WO_2 and H_3BO_3 were formed for $UO_2 - WB_2$, and Ta_2O_5 and H_3BO_3 for $UO_2 - TaB_2$. It was considered that the boron element migrated out of specimens in the form of a gaseous compound. There were no reactions between UO_2 and borides in steam. In the sintered pellet specimen of $UO_2 - WB_2$, there were no appreciable changes in the shape and location of the WB_2 particles even after heating at 600°C, while in the $UO_2 - TaB_2$ specimen a new phase, which was considered as Ta_2O_5, appeared in the annulus region surrounding each TaB_2 particle after heating at 600°C, although no appreciable migration of TaB_2 particles was observed. The effect of pressurizing of steam on the behaviors of $UO_2 - WB_2$ and $UO_2 - TaB_2$ was not recognized in the temperature range below 400°C. (auth)

17174 HEATS OF IMMERSION IN THE THORIUM OXIDE–WATER SYSTEM. III. VARIATION WITH SPECIFIC SURFACE AREA AND OUTGASSING TEMPERATURE. Fuller, E. L. Jr.; Holmes, H. F.; Secoy, C. H.; Stuckey, J. E. (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 72: 573-7(Feb. 1968).

The heats of immersion of thorium oxide samples in water show that there are three modes of interaction of water with the surface and further elucidate the temperature realms of stability for these surface species. Considerable evidence is shown that high-temperature calcination produces material that is nearly devoid of the high-energy surface heterogeneities present in the original high surface area material. These conclusions are based on data for 25 to 500°C outgassing of thoria samples with specific surface areas ranging from 1 to 35 m^2/g. Samples with high specific surface areas liberated a portion of their immersional heat via two kinetically controlled processes in addition to the instantaneous portion. (auth)

Structure and Phase Studies

Refer also to abstracts 17142, 17168, and 17775.

17175 (JAERI-4042) STRUCTURE AND FORMATION OF THE CARBIDES OF URANIUM. Tagawa, Hiroaki (Japan Atomic Energy Research Inst., Tokyo). 1968. 25p. (In Japanese and English). Dep.

The literature on the carbides of uranium is reviewed, including the crystal structures, thermodynamics and formation of the carbides. Mono- and di-carbide of uranium as nonstoichiometric compounds are described, with emphasis on the phase diagram, and the effect of impurities (oxygen and nitrogen etc.) on the lattice dimensions. The conditions for the formation and stability of the carbides are also discussed in their thermodynamics. The mechanism of formation of uranium carbides are considered from the aspect of self-diffusion in the carbides. (auth)

17176 (ORNL-TM-2106) REVIEW AND ANALYSIS OF PHASE BEHAVIOR AND THERMODYNAMIC PROPERTIES OF THE PLUTONIUM–NITROGEN SYSTEM. Spear, K. E.; Leitnaker, J. M. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 24p. Dep. CFSTI.

The phase behavior and thermodynamic properties of the plutonium-nitrogen system are reviewed and analysed. The section on phase behavior includes the subjects: intermediate phases, composition limits and lattice parameters, phase transitions, melting behavior, and vaporization behavior. Ternary or more complex systems involving plutonium and nitrogen are not considered in this analysis. In the section on the thermodynamic properties of plutonium nitride, it is shown that with the use of reasonable values estimated for the entropy and high-temperature heat capacity of PuN, all existing experimental data can be readily explained and combined into a consistent set of thermodynamic values for the mononitride. (auth)

17177 CONTINUOUS SERIES OF SOLID SOLUTIONS IN TiO_2–$CrNbO_4$ SYSTEMS. Velikodnyi, Yu. A.; Kovba, L. M.; Trunov, V. K. Zh. Neorg. Khim., 12: 3212-13(Nov. 1967). (In Russian).

The rutile-type compound $CrNbO_4$ was studied to determine the occurrence of metal–metal interactions and to investigate the potential existence of solid solutions in the TiO_2–$CrNbO_4$ system and the dependence of the c/a ratio on the composition of the solid solutions. Pressed stoichiometric mixtures of Cr_2O_3, Nb_2O_5, and TiO_2 were calcined at 1300°C for 40 hours to prepare the specimens. X-ray diffraction pictures revealed that a continuous series of solid solutions exist in the system. Lattice parameters increased uniformly from TiO_2 toward the $CrNbO_4$ end of the phase diagram. The observed slight decrease of the c/a ratio toward $CrNbO_4$, which in the 0 to 40% TiO_2 range could represent only the experimental error, may be due to a weak metal–metal interaction. (TTT)

17178 NON STOICHIOMETRIC PHASES IN THE SYSTEMS CeF_3-OXIDES OF DI, TRI, AND TETRAVALENT METALS. Besse, Jean-Pierre; Capestan, Michel (Faculte des Sciences, Clermont-Ferrand, France). Bull. Soc. Chim. Fr., No. 12, 4680-5(Dec. 1967). (In French).

The systems cerium III fluoride–oxides MO_2(M = Th), M_2O_3(M = La, Pr and Y), and MO(M = Mg, Ca, Sr, Ba) were investigated. Near the compositions $(MCe)(OF)_2$ solid solutions were obtained for all systems. Some of the phases were fluorite type cubic, others presented rhombohedral or orthorhombic deformations. Cell parameters are given for the equimolecular compositions. The occurrence of two different substitution modes was demonstrated, but, for the first time an intermediate substitution mode was observed for the system CeF_3–CaO. (auth)

17179 CONTRIBUTIONS ON THE CHEMISTRY OF THE ELEMENTS NIOBIUM AND TANTALUM. 63. PREPARATION AND CRYSTAL STRUCTURE OF $NbO_{2.483}$. Gruehn, R.; Norin, R. (Univ., Goteborg. Univ., Stockholm). Z. Anorg. Allg. Chem., 355: 176-81(Nov. 1967). (In German).

Crystals of $NbO_{2.483}$ were prepared by chemical transport in the presence of $NbCl_5/NbOCl_3$ as transporting agent. $NbO_{2.483}$ is consumed in the hot zone (1080°C) and deposited in the less hot zone (980°C). Pure $NbO_{2.483}$ was prepared in the presence of a given molar ratio of CO_2 and CO in order to keep $p(O_2)$ constant. From x-ray investigations the following lattice constants were obtained: $a = 63.52$; $b = 3.827$; $c = 21.150$ Å; $\beta = 94.08°$. The structure is probably a combination of those of H–Nb_2O_5 and $Nb_{25}O_{62}$. (auth)

17180 EFFECT OF CRYSTALLOGRAPHIC ORIENTATION ON THE DISSOLUTION OF URANIUM DIOXIDE IN NITRIC ACID. Shabbir, M.; Robins, R. G. (Univ. of New South Wales, Kensington, Australia). J. Nucl. Mater., 25: 236-7(1968).

The results of etching experiments on polished polycrystalline UO_2 pellets indicated that over a range of nitric acid concentration of 1 to 37 molal there is a preferential attack on grains with $\{100\}$ parallel to the surface and comparatively little attack on grains with $\{111\}$ orientation. The stability of $\{111\}$ surfaces of UO_2 in nitric acid is consistent with the Donnay-Harker principle concerning the dominant habit of a crystal species relative to its space group, in this instance unaffected by the solution environment. (P.C.H.)

17181 INVESTIGATIONS IN THE REGION OF SUBOXIDES OF METALS OF THE TRANSITION GROUP. Kornilov, I. I. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1851-61(Oct. 1967). (In Russian).

The reaction for the formation of suboxides among the metals of the transition group, being characterized by the incompleteness of the d-electron shell, was studied. The metals of the following groups were considered in particular: IVa(Ti, Zr, Hf), Va(V, Nb, Ta), and Vla(Cr, Mo, W). A series of suboxides of different stoichiometric composition was established. On the basis of the systems examined, Ti – 0 and Zr – 0, it was shown that the compositions of the suboxides (M_60 and M_30) on the composition–property diagram are distinguished by singular points. The characteristics of the formation reactions are that they proceed very slowly. On the example of some transition metal–oxygen systems (Ti– and Zr–O) it was shown that the character of the chemical bonds in these systems depends on the concentration of the oxygen atoms in the solid solution, suboxides, and oxides. The gradual transition from metallic to covalent and ionic bonds with gradual transition from solid solutions to suboxides and higher oxides was shown. (tr-auth)

17182 EFFECT OF M–M INTERACTION ON THE STRUCTURAL AND THERMODYNAMIC PROPERTIES OF CARBIDES, NITRIDES, AND OXIDES OF METALS OF THE IVa AND Va SUBGROUPS. Gel'd, P. V.; Tskhai, V. A.; Shveikin, G. P.; Perelyaev, V. A. (Inst. of Chemistry, Sverdlovsk, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1835-41(Oct. 1967). (In Russian).

The results of previous studies in which different aspects of the effects of the screening of the M–M bonds on the structure, phase, and thermodynamic properties of cubic carbides, nitrides, and oxides of the metals of the IVa and Va subgroups were generalized. The overlapping integrals of the d_ε orbits in the intermediate oxides of the metals of the IVa and Va subgroups, being characterized by structures of the NaCl, corundum, and rutile types were calculated. The results obtained and the consideration of the shielding of the M–M bonds made it possible to explain the structure deformation, observed in the oxides and the absence of stable of the intermediate oxides in the Zr–ZrO_2, Ta–Ta_2O_5, and Hf–HfO_2 systems. (tr-auth)

17183 SOME PROPERTIES OF SINTERED WC–NbC-10 PERCENT Co ALLOYS. Suzuki, Hisashi; Yamamoto, Takaharu; Kawakatsu, Ichiro (Tokyo Univ.). Nippon Kinzoku Gakkaishi, 31: 1368-73(1967). (In Japanese).

Properties of various WC–NbC-10% Co alloys (vacuum-sintered at 1375°C for 1 hr) were examined in relation to their niobium carbide and carbon contents. The results were compared with previous results on the properties of WC–TaC-10% Co, WC–TiC-10% Co alloys. Niobium carbide hardly dissolved in the binder phase at room temperature, in the same way as tantalum carbide or titanium carbide in cemented carbides. The niobium carbide phase contained about 18% WC at room temperature, which was about three times larger than in the tantalum carbide phase. The composition of the binder phase and the carbon content of the niobium carbide phase varied regularly with small changes in carbon content. This resulted in the regular changes in various properties of the alloys, as has been observed in alloys containing tantalum carbide or titanium carbide. The (WC + NbC + γ) three-phase region of the alloy was extended with increasing niobium carbide content. The amount of the extension was intermediate between those of WC–TaC–Co and WC–TiC–Co alloys. The phase boundary between the (WC + NbC + γ) three-phase and (NbC + γ) two-phase regions was found at the content of about 75% NbC in the alloys (about 83% in carbides); that is, the boundary located at the higher WC content than that of tantalum carbide containing alloys. The niobium carbide content on the boundary, as in the case of tantalum carbide containing alloys, slightly increased with increasing carbon content. The hardness of the alloys was superior to that of WC–TaC–Co alloys, but the transverse-rupture strength was lower. The effect of niobium carbide content on the properties was confirmed to be intermediate between those of tantalum and titanium carbide contents. (auth)

17184 PHASE EQUILIBRIUM IN THE BINARY ZIRCONIUM–OXYGEN SYSTEM AND NEW Zr_6O AND Zr_3O SUBOXIDES. Kornilov, I. I.; Glazova, V. V.; Kenina, E. M. Zh. Neorg. Khim., 12: 2812-17(1967). (In Russian).

The phase equilibrium of Zr–O system with concentration range up to 28 at. % was studied. The microstructure analysis of alloys annealed at 800 and 600°C showed that alloys containing less than 8 at. % O have a single-phase structure, while most alloys with oxygen content exceeding 8 at. % O exhibited some regions containing second phase structure. However, alloys with 25 to 26% O had only one phase structure. After annealing at 1000°C all alloys, except those found in the $\alpha + \beta$ region, had one phase polyhedron structure. Data obtained from a newly constructed phase diagram of Zr–O system with suboxide composition Zr_6O and Zr_3O showed that in the α-solid solution the content of oxygen is 8 at. % and not 29 at. % O, as was reported previously. New compounds of suboxide composition Zr_6O and Zr_3O with 14.5 and 25 at. % O were found in the Zr–O systems. The stability of Zr_6O was retained up to 940°C, while Zr_3O was stable only up to its melting point. (R.V.J.)

Radiation Effects

Refer also to abstract 17150.

17185 (BAW-3809-1) POST IRRADIATION EXAMINATION OF THORIA-URANIA FUEL RODS. Quarterly Progress Report No. 1, March-August 1967. Bishop, W. N.; Marsh, S. F.; Baroch, C. J. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Jan. 1968. Contract AT(30-1)-3809. 34p. Dep. CFSTI.

Thirteen fuel rods composed of ThO_2-UO_2 mixtures contained in six fuel elements were selected for post irradiation examination. Eleven of these rods have been removed from four of the elements. A rapid sequential chemical separation procedure for uranium, plutonium, americium-curium, cesium, neodymium, promethium, and samarium has been adapted from a separation procedure used for burnup analysis of uranium fuels. (auth)

17186 (GEAP-5100-M) HIGH PERFORMANCE UO_2 PROGRAM. HIGH BURNUP IRRADIATIONS OF POWDER AND PELLET UO_2 FUEL RODS AT PEAK HEAT FLUXES UP TO 1.3 x 10^6 Btu/h-ft^2. Lyons, M. F.; Boyle, R. F.; Pashos, T. J.; Wilson, C. R.; Weidenbaum, B. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). Oct. 1966. Contract AT(04-3)-189. 140p. (EURAEC-1766). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The fabrication data, irradiation history, and the complete correlated post-irradiation examination results are described for a four-rod fuel assembly—designated EX-12A—that was irradiated in the GETR to high burnup while operating with gross center melting. Each fuel rod was an unsegmented, reactor length rod, clad in freestanding Zircaloy-2. Two of the assembly fuel rods initially contained vibratory compacted UO_2 and had previously been irradiated to a nominal average burnup of 10,000 MWd/te in preceding assembly EPW-12V. These two rods accumulated an additional 10,000 MWd/te average burnup or 20,000 MWd/te total during the EX-12A irradiation. The other two rods contained cored pellet UO_2 fuel and were essentially unirradiated prior to the EX-12A operation. These two rods reached approximately 12,000 MWd/te burnup. This fuel assembly was the terminal irradiation of the AEC-Euratom High Performance UO_2 Program conducted to determine the feasibility and limitations in operating UO_2 fuel rods with central melting. This final assembly was preceded by twelve previous assemblies in two separate series of exploratory irradiations; a first with sintered pellet UO_2 fuel and then a second with compacted powder UO_2. The earliest pellet fuel irradiations demonstrated that clad swelling from the UO_2 phase change volume expansion was the basic problem in operating with central melting. Further tests demonstrated that the clad swelling could be prevented by the provision of internal free volume to accommodate the UO_2 volume expansion. Hollow pellets were used to provide the required internal free volume in sintered pellet fuel and the initial, bulk fuel density was reduced to achieve the same objective with compacted powder fuel. With this accommodation, extended, satisfactory operation at central melt conditions was achieved with both fuel types; to greater than 5000 MWd/te average burnup with cored pellets in assembly EPT-12C, and to greater than 10,000 MWd/te with vipac powder in assembly EPW-12V. Eventually, rod failures occurred in both the above assemblies but evaluation showed the failures were not caused by any fundamental life limitation associated with central melting and therefore, could be prevented. On this basis, the irradiation of a final fuel assembly, EX-12A, containing two pellet and two powder rods was undertaken to investigate higher burnups. Assembly EX-12A operated satisfactorily for five full GETR reactor cycles at the maximum permissible thermal performance in the PWL. Detailed destructive examinations were performed on three of the four assembly fuel rods following irradiation. No evidence of rod deterioration was found that would preclude their continued operation to higher burnups. This experience is considered to demonstrate the basic feasibility of operating rods with gross central melting to high burnups. (auth)

17187 SOME EFFECTS OF IRRADIATION AT 77°K ON THE PHYSICAL PROPERTIES OF GRAPHITE. Goggin, P. R. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 16: 1221-39(Dec. 1967).

Samples of reactor graphite were irradiated at 77°K with neutrons, and earlier work with electrons was extended to higher doses to enable comparisons to be made. Changes in the electrical resistance, magneto-resistance, Hall constant, and dynamic and static Young's moduli were studied as a function of irradiation dose and annealing. The rate of change of the properties as a function of the number of displaced atoms differed for the two types of irradiation. Estimates of the number of trapped electrons and changes in the carrier mobility show that there are more trapped electrons per displaced atom for the neutron irradiations, but the scattering power of the traps is the same in both cases. Analysis of the changes in Young's moduli shows that neutron irradiation produces damage in which some of the interstitials are already clustered. Inverse annealing effects occur in the electrical properties in the range 100 to 160°K, and in the mechanical properties in the range 200 to 280°K. The annealing behavior of the neutron irradiated samples was more complex than that of the electron irradiated samples. It is shown that all the results are consistent with a model for neutron damage in which the displaced atoms are in small loosely coupled clusters, of about 10 interstitials, distributed along the paths of the primary knockons, and for electron irradiation a model in which the damage consists mainly of randomly distributed simple Frenkel pairs. (auth) (UK)

17188 EXAMINATION OF IRRADIATED NUCLEAR FUELS. PART I. Lambert, J. D. B. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Energy, 2-12(Jan.-Feb. 1968).

The examination of irradiated fuel elements by X-radiography, and techniques of image recovery from background fogging are discussed. Apparatus for applying X-ray scintillography to detect an X-ray signal from a high background of γ-rays is briefly described. Microradiographic and metallographic results on carbide fuels are compared. A description is presented of methods and equipment for burnup determination, and fission gas release measurement. (UK)

17189 IRRADIATION BEHAVIOUR OF PLUTONIUM-BEARING CERAMIC FUEL PINS. Lawton, H.; Bagley, K. Q.; Edmonds, E. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 631-54 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Irradiation experience of mixed oxide (U, 15 at. % Pu) fuel pins clad in type 316 stainless steel is reported. The elements, which contained a plenum to accommodate fission product gases, were mostly irradiated at ratings of 160 to 230 w/g to burn-up levels of 7%, with maximum cladding temperatures of 600 to 700°C. The fabrication and irradiation techniques are outlined. Post-irradiation results obtained by radiography, gamma scanning, mensuration, fission gas extraction, and metallography are presented. Fuel and cladding behavior were found to be satisfactory up to 5% burn-up, but above this fuel swelling began to strain the can. (UK)

17190 TEMPERATURE DEPENDENCE OF THE EFFECTIVE RESONANCE INTEGRAL OF THORIUM OXIDE RODS. Kadlecek, J. A.; Schoenig, F. C.; Quisenberry, K. S. (Knolls Atomic Power Lab., Schenectady, N. Y.). Contract W-31-109-eng-52. Nucl. Sci. Eng., 31: 541-5(1968). (KAPL-P-3348).

Thorium oxide pellets were assembled into rods and irradiated in a Cd covered Ar-filled furnace in an investigation of the temperature dependence of the effective resonance of ThO_2 rods. The reaction $^{232}Th + n \rightarrow {}^{233}Th \rightarrow {}^{233}Pa \rightarrow {}^{233}U$ takes place. The 0.310 MeV γ activity from the decay of ^{233}Pa is directly related to the relative number of absorptions occurring in the Th, therefore this γ activity measurement provides a measure of the relative change of the effective ThO_2 resonance integral with temperature. (F.S.)

17191 SYNERGISTIC AND ACCELERATED TESTING EFFECTS ON SPACE THERMAL-CONTROL MATERIALS. Pinson, J. D. (Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio); Wiebelt, J. A. Contract AF40(600)-1122. J. Spacecraft Rockets, 4: 1511-16(Nov. 1967).

The effects of vacuum, temperature, proton radiation, and electromagnetic radiation on thermal-control materials were studied. Synergistic testing as a function of particle radiation and ultraviolet radiation was conducted to evaluate the combined environmental optical degradation. The thermal coating used in most of the testing was TiO_2/polymethyl siloxane (pigment/vehicle). Its initial degradation rate was high, but then it appeared to saturate at some equilibrium value of solar absorption. The spectral reflectance data showed more degradation in the ultraviolet and visible region than in the infrared region of the electromagnetic spectrum. Degradation was found to be a function of proton energy and sample temperature and independent of proton flux. Synergistic effects were very pronounced in the combined environmental testing of the material. The calculated proton penetration ranges correlated with the microscopic analysis of the degradation depth. (auth)

17192 THERMAL NEUTRON-INDUCED DEFECTS IN n-TYPE CADMIUM TELLURIDE. Barnes, Charles; Kikuchi, Chihiro (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng., 31: 513-20(1968).

During thermal-neutron irradiation, Frenkel defects are produced in CdTe due to the recoil of ^{114}Cd following radiative capture by ^{113}Cd. The properties of these defects can be studied by measuring the Hall effect and electrical conductivity before and after successive irradiations. The results indicate that the cadmium vacancy is responsible for electron removal in n-type CdTe and that the introduction rate of cadmium vacancies is strongly influenced by annealing during irradiation. (auth)

17193 CORRELATION OF GRAPHITE IRRADIATIONS. Gray, B. S.; Thorne, R. P. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). J. Brit. Nucl. Energy Soc., 7: 91-9(Jan. 1968). (TRG-Report-1152).

In connection with the development of the advanced gas-cooled reactor system, data on the effects of neutron irradiation on the physical properties of graphite were examined when irradiating specimens in reactors with different neutron spectra. In order to ensure that the data obtained can be quantitatively related and used to predict the behavior of graphite in a specific reactor design, adjustments must be made. Studies to allow the adjustments to be made on the data obtained are described. (auth) (UK)

Plastics and Other Materials

Refer also to abstracts 16883, 17150, 18667, and 18679.

17194 RADIATION WINDOW GLASS. Harrington, Roy V. (to Corning Glass Works). U. S. Patent 3,356,579. Filed Jan. 29, 1964.

A glass, resistant to dielectric breakdown from gamma radiation of up to about 10^8 roentgens, consisting essentially of 47.2 wt % SiO_2, 33 wt % PbO, 17 wt % K_2O, and 2.8 wt % CeO_2, is described. The glass is characterized by being substantially free of halogens, soda, and lithia, having an initial luminous transmittance for a one inch thickness of greater than 90% at a wavelength of 5500 Å, and having an electrical resistivity in terms of the log of the resistivity at 50°C of less than 16.5. (Offic. Gaz.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 17364, 17429, 17432, 17433, 17519, 17642, 17921, 18205, and 18322.

17195 (UCRL-Trans-10206) GRAVITATIONAL COLLAPSE OF A NEUTRON STAR. (Rome Univ. (Italy)). Translated by C. Gillam for Univ. of California Lawrence Radiation Lab., Livermore, from Internal Report No. 66/4. 25p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

A numerical method was studied to integrate the system of partial differential equations which determines the evolution of a perfect fluid in general relativity. The method was used to calculate the evolution of a neutron star with a mass greater than $0.7M_{\odot}$ in the neighborhood of its Schwarzschild singularity. (auth)

17196 THERMODYNAMICAL CONDITIONS IN STELLAR INTERIORS. Rakavy, G. (Hebrew Univ., Jerusalem). pp 226-31 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

The author points out that stars may turn out to be exotic laboratories where we might check some of our ideas on nuclear, elementary-particle, and even solid-state physics. Briefly outlined here are the kind of thermodynamic conditions likely to be encountered in these unusual laboratories; specifically, what temperatures and densities can be reached by "regular" evolution, and when one can expect more extraordinary conditions. (L.M.T.)

17197 SOLAR NEUTRINOS. Bahcall, John N. (California Inst. of Tech., Pasadena). pp 232-55 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

Some experiments to detect neutrinos produced in the interior of the sun are discussed, and an outline is given of nuclear reactions in stars including the sun. A few remarks on the early history of the theory of nuclear reactions in stars are made, and fusion reactions among the light elements are described. The construction of a detailed stellar model is indicated, and a theoretical neutrino spectrum for the sun obtained from such a model is shown. It is found that a theory with a gravitational constant that varies with time predicts a different flux of the most easily detected neutrinos from that predicted from general relativity theory. A chlorine-37 experiment and other experiments are discussed. (J.F.P.)

17198 DECAMETRIC RADIATION FROM JUPITER AND IONOSPHERIC DISTURBANCES INDUCED BY ARTIFICIAL SATELLITES. Tituri, M. E. (Technical Univ. of Helsinki). Planet. Space Sci., 15: 1203-10(July 1967).

Similarities between satellite-induced ionospheric disturbances (SIID) and Jupiter's decametric emission were studied. It is shown that both phenomena depend in the same general way on the position of the satellite (an artificial satellite or Io) with respect to the most northerly or most southerly point of the orbit. It is further shown that SIID and decametric emissions favor about the same satellite positions with respect to the Sun. The frequency spectra and some other characteristics of decametric emissions were studied and explained assuming that SIID and the emissions are related phenomena. (auth) (UK)

17199 NUCLEOSYNTHESIS IN BIG AND LITTLE BANGS. Fowler, William A. (California Inst. of Tech., Pasadena). pp 203-25 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

The subject is reviewed according to the following topics: the site of nucleosynthesis; abundances in the oldest stars; universal synthesis in the big bang; behavior of expanding matter and radiation; the nuclear reactions; neutrino or antineutrino degeneracy; and supermassive stars. 66 references. (L.M.T.)

17200 THE SOLAR SPECTRUM IN THE 5577 AND 6300 A REGIONS. Roland, G.; Delboville, L. Planet. Space Sci., 15: 945-9(May 1967).

A prism grating spectrometer with a half-width resolution of 7 to 8 mÅ was used to measure the solar spectrum over the appropriate ranges, the regions near the [O I] lines at 5577 and 6300Å being shown in detail. It is suggested that such recordings will be of use in deriving the apparent solar spectrum as observed through narrow band filters used for daylight observations of atmospheric lines. (UK)

17201 ON THE THREE-DIMENSIONAL STRUCTURE OF THE SOLAR PLASMA FLOW GENERATED BY SOLAR FLARES. Akasofu, S. I.; Yoshida, S. Planet. Space Sci., 15: 942-4(May 1967).

The results of earlier work by these authors (Planet. Space Sci. (GB), Vol. 15, No. 1, 39-47 (Jan. 1968)) were confirmed and extended by increasing the number of events studied. The data are used to deduce the form of the plasma flow generated by solar flares. (UK)

17202 THE MEASUREMENT OF ABUNDANCES IN PLANETARY ATMOSPHERES USING AN IMAGE INTENSIFIER AND A SOLAR SPECTROGRAPH. Beckman, J. E. (Oxford Univ.). Planet. Space Sci., 15: 1211-18(July 1967).

An image intensifier tube was used in conjunction with the solar installation at Oxford to obtain high-resolution spectra of the plants Venus and Jupiter. The spectra of Jupiter were used to obtain the equivalent width of the S(1) line of the quadrupole (4,0) band of molecular hydrogen, and thus the amount of hydrogen in the atmosphere of Jupiter. The result is 75 km-amagat of hydrogen above the reflecting layer. The spectra of Venus were used to set an upper limit to the abundance of oxygen in its atmosphere. The result is 1.75 m-amagat of oxygen above the reflecting layer. (auth) (UK)

17203 THE BRIGHTNESS TEMPERATURE OF VENUS AT 49.1-cm WAVELENGTH. Barber, D.; Gent, H. Planet. Space Sci., 15: 907-15(May 1967).

The planet Venus was observed at 49.1 cm wavelength during closest approach in 1964 and was found to have a brightness temperature of 580 ± 100°K. The measurements were made with an interferometer of 190 m East–West spacing to minimize interference due to the Sun. The celestial background was observed separately in the absence of the planet, giving measures of the confusion; these were subtracted vectorially from the planetary measurements to give the true brightness temperature of Venus. Comparison with results obtained elsewhere, between 0.32 and 70 cm wavelength, shows that the brightness temperature of Venus falls from approximately 630°K at 10 cm to approximately 530°K at 70 cm. The radio spectrum of the Cytherean radiation is discussed. (auth) (UK)

17204 A MEASUREMENT OF THE SOLAR X-RAY FLUX IN THE WAVELENGTH RANGE BELOW 5 A. Bowles, J. A. (University Coll., London); Culhane, J. L.; Sanford, P. W.; Shaw, M. L.; Cooke, B. A.; Pounds, K. A. Planet. Space Sci., 15: 931-5(May 1967).

Two beryllium windowed proportional counters were used to measure the solar x-ray flux in the wavelength band below 5 Å. They were flown on a Centaure rocket launched from a site near Karystos in Greece. The counters and their associated electronics are briefly described. The shape of the spectrum is estimated by considering the variation in counting rate as the rocket ascended through the atmosphere. A comparison of the present result with other measurements suggests that the spectral slope and intensity are extremely variable in this part of the spectrum. (auth) (UK)

17205 RADIATIVE RELAXATION TIMES FOR MARS. A DISCUSSION OF MARTIAN ATMOSPHERIC DYNAMICS. Goody, R.; Belton, M. J. S. Planet. Space Sci., 15: 247-56(Feb. 1967).

Radiative relaxation times were computed for temperature perturbations in CO_2 with small admixtures of water vapor under conditions similar to those occurring in the Martian atmosphere. Certain aspects of the influence of radiative transfer on dynamical phenomena in the Martin atmosphere are discussed in terms of these radiative relaxation times. It is found that: (i) diurnal changes in the temperature profile will extend to considerably greater heights in the Martian atmosphere than is the case on Earth; the diurnal wave will propagate more by radiative transfer than by turbulent diffusion; (ii) a nonnegligible diurnal wind system exists on Mars; (iii) nonlinear interactions between the motion field and the initial state of radiative equilibrium are much smaller on Mars than on Earth; (iv) radiative destabilization of regions with a negative lapse rate may be important in the upper Martian atmosphere. (auth) (UK)

17206 SOLAR X-RAY FLUX MEASURED BY THE 1964-01-D SOLAR RADIATION SATELLITE DURING THE IQSY. Landini,

M.; Russo, D.; Tagliaferri, G. L. (Acretri Observatory, Florence). Planet. Space Sci., 15: 231-8(Feb. 1967).

The solar x-ray fluxes recorded at Arcetri (Florence) (in the 44 to 60, 8 to 12, and 0 to 8 Å bands) by telemetering the 1964-01-D Solar Radiation Satellite during the period from March 1, 1964 to February 28, 1965, are presented. Solar x-rays and decimetric radio emission are compared, and the minimum of solar x-ray activity is determined. The observed fluxes in the 8 to 12 Å band are compared with the theoretical values, and the brightness distribution on the disk is discussed. X-ray measurements taken at the same time as optical flares are also examined. (auth) (UK)

17207 COMPATIBILITY OF VARIOUS INTERPLANETARY FIELD MODELS WITH COSMIC-RAY MODULATION DATA. **Quenby, J. J. (Imperial Coll. of Science and Tech., London). Planet. Space Sci., 15: 257-75(Feb. 1967).**

Convective diffusion models for the motion of cosmic rays in the interplanetary electromagnetic field are presented for both isotropic and anisotropic diffusion situations. Measurements of the long-term modulation, including high-altitude data obtained in 1965, fit the following simple model. Spherical symmetry is assumed for the solar cavity, with the boundary at 50 au. In the solar equatorial plane the magnetic field follows the Archimedian spiral predicted by Parker, with superimposed scattering centers. The particle mean free path, λ, is proportional to r^2 where r is the distance from the Sun. Between particle rigidity limits 1 GV < P < 15 GV, $\lambda \propto P$ throughout the solar cycle, whereas below 1 GV observations close to solar minimum show that λ is independent of rigidity. A modulation theory based on energy loss alone in a scalar electric potential field, even when the path traversed is rigidity-dependent, does not explain the experimental observations. (auth) (UK)

17208 ROTATIONAL EFFECTS ON THE DISTRIBUTION OF THERMAL PLASMA IN THE MAGNETOSPHERE OF JUPITER. **Melrose, D. B. (Univ. of Sussex, Brighton, Eng.). Planet. Space Sci., 15: 381-93(Feb. 1967).**

The consequences of the assumption that the magnetosphere of Jupiter co-rotates with the planet are examined. It is found convenient to divide the magnetosphere into two regions. The inner region is qualitatively similar to the magnetosphere of the Earth, provided that the ratio of the scale height to the radius of Jupiter is much less than $^1/_{12}$. The outer region is dominated by rotational effects, and is expected to be slightly flattened, with a density falling off as Br^{-1}. The velocity distribution of the plasma becomes increasingly anisotropic with increasing distance. The co-rotating magnetosphere breaks up as a result of electrostatic microinstabilities at 7 to 8 radii, well inside the boundary with the solar wind. (auth) (UK)

17209 ISOTROPIC BACKGROUND COSMIC X RAYS IN THE ENERGY RANGE 50 TO 290 keV. **Rao, U. R.; Chitnis, E. V.; Prakasarao, A. S. (Physical Research Lab., Ahmedabad, India). Proc. Indian Acad. Sci., Sect. A, 46: 353-9(Dec. 1967).**

The observations of omnidirectional x-ray flux at the top of the atmosphere have been extended up to 200 keV using a balloon-borne NaI (Tl) scintillator detector at Hyderabad, India. The omnidirectional flux at 60 keV was found to be 0.0066 ± 0.0014 photons/cm^2 sec ster keV. The x-ray flux in the energy range 50 to 290 keV can be adequately represented by the spectrum $KE^{-2.2\pm0.4}$. New upper limits to the hard x-ray flux from the quiet Sun were also obtained from the same measurement. (auth)

17210 DETERMINATION OF THE ELECTRIC SEMI-CONDUCTION IN THE BINARY OXIDE ZIRCONIA–CERIUM OXIDE. **Millet, Jacques; Guillou, Michel (Electricite de France, Clamart). J. Chim. Phys., 64: 1726-33(Nov.- Dec. 1967). (In French).**

The electric and ionic conductivity of ZrO_2-CeO_2 with 5 to 25% CeO_2 was measured using crystallography, dilatometry, and porosity techniques. The measurement of the total electric conductivity was conjugated as a function of the chemical potential of oxygen around the sample with the determination of the ionic transference number. The binary oxide ZrO_2-CeO_2 showed, both at low and high temperatures, a total conductivity highly dependent of the partial pressure of oxygen. This behavior is characteristic of n-type electric conductivity with a maximum for 19% CeO_2. The electronic transference number is important, between 30 and 80%, depending on composition and temperature. The highest electric conductivity was obtained with 25% CeO_2, the transference number of which, measured with the oxygen partial pressure couple $^1/_{10}{}^{-3}$, was between 0.53 and 0.29 at 1,200 to 1.900°K. (auth)

17211 THE UPPER ATMOSPHERE OF VENUS. **McElroy, Michael B. (Kitt Peak National Observatory, Tucson, Ariz.). J. Geophys. Res., 73: 1513-21(Mar. 1, 1968).**

The photochemistry of CO_2 on Venus is discussed in the light of recent data obtained from Mariner 5 and Venus 4. It is suggested that preliminary data indicate that recombination of CO and O proceeds rapidly by formation of an unstable CO_3 couplex. Models for the thermal structure of the Venus atmosphere are presented. These models are characteristized by a remarkably small temperature lapse rate, about 2°K km^{-1}, in the stratosphere. The scale height is approximately constant and equal to 5 km over an altitude range in excess of 50 km. The exospheric temperature is of the order of 700°K. It is suggested that dissociative recombination of CO_2^+ could provide an important source of airglow emission in the fourth positive bands of CO. This emission system could account for the weak unidentified ultraviolet airglow detected by Mariner 5. The possibility of an important proton component of the Venus ionosphere is discussed. In particular, it is suggested that diffusion of proton from the sunlit hemisphere may provide an important nighttime source of ionization on Venus. (auth)

17212 NOTES ON THE LUNAR MAGNETOSPHERE. **Johnson, F. S.; Midgley, J. E. (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 73: 1523-32(Mar. 1, 1968).**

A number of models are considered for the electrical properties of the Moon, and the interaction of each with the solar wind is described in detail for various angles of the interplanetary magnetic field. In general, a permanent shock will form ahead of the Moon if its surface conductivity is high, a temporary shock will form if it has a very large conducting core, and no shock will form if there is a thick surface layer of poor conductivity. The rate at which the void behind the moon is filled depends on the orientation of the interplanetary field and its relative strength. The field depressions observed by Colburn et al., in the Moon's plasma penumbra are explained qualitatively by the expansion of the plasma there. (auth)

17213 MAGNETIC FIELD STRUCTURE BEHIND THE MOON. **Michel, F. C. (Manned Spacecraft Center, Houston, Tex. Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 1533-42(Mar. 1, 1968).**

Details concerning the magnetic field structure expected on the basis of the author's model of solar wind interaction with the moon are discussed. A derivation is presented that supports the finding of Colburn et al., that the magnetic field in the plasma void region downstream of the moon (relative to the solar wind flow) is more intense than the ambient interplanetary magnetic field. In the expansion region surrounding the void, the field is less than ambient. These effects should be smallest when the magnetic field is perpendicular to the flow vector. A standing shock wave trailing several lunar radii behind the moon is expected regardless of the magnetic field orientation. (auth)

17214 PROTONS ASSOCIATED WITH CENTERS OF SOLAR ACTIVITY AND THEIR PROPAGATION IN INTERPLANETARY MAGNETIC FIELD REGIONS COROTATING WITH THE SUN. **Fan, C. Y.; Pick, M.; Pyle, R.; Simpson, J. A.; Smith, D. R. (Univ. of Chicago). J. Geophys. Res., 73: 1555-82(Mar. 1, 1968).**

Pioneer 6 and 7 space probes carried charged-particle telescopes that measured, for the first time, both the direction of arrival and differential energy spectra of protons and alpha particles over the energy range 0.6 to ~100 MeV nucleon. The background counting rate is reduced by using an anticoincidence shield around the telescope so that proton flux changes as small as ~10^{-3} particles/cm^2 sec ster are detected with a time resolution of ~one hour. Near the beginning of the new solar activity cycle (no. 20) over the period December 1965–September 1966, proton flux increases have been associated unambiguously with specific centers of solar activity. The origin and propagation of these protons in the corona and interplanetary space have been investigated for this period. Enhanced proton fluxes in the energy range 0.6 to 13 MeV have been observed to come from the Sun continuously over heliocentric longitude ranges as great as 180° in association with specific active regions. The enhanced fluxes exhibit definite onsets when the active centers reach ~60 to 70° east of central meridian, and cutoffs when the center reaches ~100 to 130° west. The onset and cutoff, together with the modulation of galactic cosmic rays, point to the existence of a corotating magnetic region associated with the active center. Superposed on the 0.6-MeV flux level are occasional large and discrete flare-produced intensity increases from these centers extending in energy to more than 50 MeV for protons. The solar electrons that appear during the initial phase of some solar flare events have been excluded by energy loss versus range measurements. The protons from flares over a longitude range of >60° are observed initially to propagate rapidly through the corona to the interplanetary field. The short transit and rise times are not explained by isotropic diffusion from the flare site across coronal magnetic fields. From these observations, a quasi-stationary model is proposed for the distribution of magnetic fields above the active center. In this model, some field lines rooted in or near the active center are spread out in the corona over a range of ~100 to 180° longitude (possibly because of the presence of superheated coronal plasma) and then extended into interplanetary space by the solar wind. Observations prove that both the enhanced and discrete flare proton fluxes propagate along the spiral interplanetary magnetic field from the western hemisphere of the Sun. Present evidence supports the view that the origin of the >0.6-MeV proton flux is in flare-like processes continually occurring in the solar active center. The existence of strong unidirectional anisotropies in the inital phases of discrete flare proton events implies that little scattering occurs in the magnetic fields between the Sun and spacecraft. However, the gradual approach to an isotropic flux at late times indicates that the decay phase is controlled by the interplanetary magnetic field beyond ~1 AU. (auth)

17215 EXPLORER 12 OBSERVATIONS OF THE MAGNETOPAUSE CURRENT LAYER. **Sonnerup, B. U. O. (Dartmouth Coll., Hanover, N. H.); Cahill, L. J. Jr. J. Geophys. Res., 73: 1757-70 (Mar. 1, 1968).**

The variation in magnetic field magnitude at magnetopause is examined with the objective of separating boundaries of the rotational-discontinuity type from those of the tangential-discontinuity type. The field magnitude should remain constant throughout the current layer in the former case but may vary considerably in the latter. Also, the field component normal to the layer may be nonzero in the former case but not in the latter. It is estimated that approximately one-third of the 91 cases examined may have been of the rotational-discontinuity type. The field component along a theoretical vector normal to the current layer is compared for the two groups. The result indicates that the normal field component, on the average, may be less than 5 γ for the rotational-discontinuity group also. For the tangential discontinuities, a normal vector, calculated from the data under the assumption of a vanishing normal-field component, is compared with a corresponding vector obtained from the Mead–Beard theoretical magnetosphere model. Substantial individual, as well as systematic, deviations are found. The latter are related to the angle between the solar wind and the earth's dipole axis. Finally, the sense of rotation of the tangential magnetic-field component at magnetopause is examined. For rotational discontinuities, the sense of rotation is found to be opposite above and below the solar-magnetospheric equatorial plane. A tentative explanation of this observation, in terms of the electrical structure of the current layer, is proposed. (auth)

17216 COSMIC DUST IN THE STRATOSPHERE. **Bhandari, Narendra; Arnold, James R.; Parkin, David W. (Univ. of California, San Diego, La Jolla). J. Geophys. Res., 73: 1837-45(Mar. 1, 1968).**

A balloon-borne technique for stratospheric collection of micron-size dust from up to a million cubic meters of air has been developed. The technique samples particles in size range of roughly 1 to 100 microns, and thus the extraterrestrial particles in this size range that do not burn up during their entry in the Earth's atmosphere are collected. The collection made during June 1966 indicates that the total terrestrial accretion of such particles certainly does not exceed 550 tons per day and is probably less than 50 tons per day. (auth)

17217 HEAT SOURCES IN INTERGALACTIC MEDIUM. **Hanif, M. (Pakistan Space and Upper Atmosphere Research Committee, Karachi). J. Natur. Sci. Math., 7: 31-5(Apr. 1967).**

The temperature of the intergalactic gas has been estimated indirectly by theoretical arguments. Of the four energy sources investigated in respect of the amount of energy required for a temperature of 10^5 K°, gravitational energy released as a result of galaxy formation and the nuclear energy source are not adequate enough. Cosmic-ray heating and heating through dynamical turbulence are found to provide enough energy. It is suggested that cosmic rays of extragalactic origin and dynamical turbulence are the main sources of energy available to heat the intergalactic medium. (auth)

17218 IDENTIFICATION OF VERY HEAVY COSMIC-RAY TRACKS IN METEORITES. **Price, P. B. (General Electric Research and Development Center, Schenectady, N. Y.); Fleischer, R. L.; Moak, C. D. Phys. Rev., 167: 277-82(Mar. 10, 1968).**

Ions of Fe, Br, and I from the Oak Ridge tandem Van de Graaff accelerator have been used to form charged-particle tracks in crystals of the minerals hypersthene and diopside, two of the most common minerals in meteorites. The results establish that the thresholds for track formation in these minerals, like those previously measured in more sensitive track-storing materials, are consistent with a primary specific ionization criterion. The direct calibration obtained for Fe ions confirms that the most abundant cosmic-ray tracks found in meteorites are due to nuclei of the Fe group (Z = 20 to 30). Together with the use of the primary ionization criterion, this calibration provides improved relations between observed track length and atomic number of slowing-down cosmic-ray ions in hypersthene and diopside. The minimum atomic numbers for track formation are Z = 25 for hypersthene and Z = 24 for diopside. Fe nuclei should leave tracks up to ~8μ long in hypersthene and up to ~15μ long in diopside. From the present work and a recent study of cosmic-ray tracks in meteorites, it is calculated that the abundance of cosmic rays with Z > 30, relative to the abundance of Fe-group nuclei, is 1/4550. (auth)

17219 SPACE DISTRIBUTION AND LUMINOSITY FUNCTIONS OF QUASI-STELLAR RADIO SOURCES. **Schmidt, Maarten (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 151: 393-409(Feb. 1968).**

The distribution in space and both the optical and radio luminosity functions of quasi-stellar radio sources are derived. The derivation is based on quasi-stellar sources in the Revised 3C Catalogue, in which they have been identified and observed with a high degree of completeness down to magnitude around 18½. The red shifts are assumed to be cosmological. The distribution in space is found to be strongly nonuniform. The space density, in co-moving coordinates, is increasing with red shift z, such that at z = 1 the density is around 150 and 80 times the local (z = 0) density for $q_0 = 0$ and $q_0 = 1$, respectively. This density increase corresponds to a N(S) relation quite similar to that exhibited by extragalactic radio sources. The optical luminosity function is relatively flat, i.e., the numbers per magnitude depend little on the luminosity. In contrast, the radio luminosity function is rather steep, the number per magnitude increasing toward fainter radio luminosities by a factor of around three to four per magnitude. Extension of this radio luminosity function by 1½ magnitude is sufficient to account for the Sandage–Luyten estimate of the sky density of quasi-stellar objects. The local (z = 0) density of quasi-stellar objects can then be estimated at 7×10^{-9} and 12×10^{-9} Mpc^{-3} for $q_0 = 0$ and $q_0 = 1$, respectively. Unpublished spectra and red shifts of quasi-stellar sources are given in the Appendix. (auth)

17220 GHOST IMAGES IN INHOMOGENEOUS FRIEDMANN UNIVERSES. **Petrosian, Vahe; Salpeter, Edwin E. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 151: 411-29(Feb. 1968).**

The general-relativistic cosmological models with nonzero cosmological constant Λ are reviewed. Some observable quantities are plotted for models with various values of Λ and density. The possibilities of focusing of light rays at the antipode of a source in a homogeneous closed world model are discussed. Only low-density Lemaître models, with Λ greater than but close to a critical value Λ_c, have sufficiently long ages to allow the formation of ghost images with reasonably small red shifts ($z \lesssim 2$). It is shown that in an inhomogeneous universe (the real world of galaxies and clusters of galaxies) the simple focusing is destroyed: (i) Instead of focusing into a point the light rays from a point source pass on the average within a distance of 10^5 to 10^6 pc of the source's antipode. (ii) The image of the source is not smeared out but is split into many images. The modification of the magnitude–red shift relation due to these effects is also discussed. (auth)

17221 SPECTROPHOTOMETRIC STUDIES OF GASEOUS NEBULAE. IX. THE DIFFUSE NEBULA, NGC 604, IN THE TRIANGULUM GALAXY, M33. **Aller, L. H. (Univ. of California, Los Angeles); Czyzak, S. J.; Walker, M. F. Astrophys. J., 151: 491-5(Feb. 1968).**

The brightest and most spectacular emission nebula, NGC 604, in the Triangulum spiral, M33, resembles the great 30 Doradus nebula in the Large Magellanic Cloud. Observations at Lick and Mount Wilson observatories reveal a low-excitation spectrum closely similar to that of the diffuse nebula associated with η Carinae. The electron density, $N_\epsilon \sim 100/\text{cm}^3$, is much lower. Not only does the He/H ratio appear to be normal as was found by Mathis, but the character of the spectrum strongly suggests that other elements such as oxygen, neon, and sulfur may also be "normal." (auth)

17222 THE HELIUM TRIPLET SPECTRUM IN EXPANDING NEBULAE. I. THE CAPTURE-CASCADE INTENSITIES. **Robbins, R. R. (Univ. of California, Berkeley). Astrophys. J., 151: 497-510(Feb. 1968).**

The equations of radiative capture and subsequent cascade are formulated and solved for the triplet states of neutral helium. Incorporating recent improvements in fundamental atomic parameters for helium, the solution explicitly takes into account all energy levels (n,l) through n = 20 and estimates the contributions of higher levels. Cross sections specifying the redistribution of electrons within higher levels by collisions are estimated and incorporated into the solution. The populations of the energy levels and relative intensities for spectral series of interest are thus obtained for T_e = 10,000° and 20,000°K and for N_e ranging from 500 to over 10^7 cm^{-3}. Density-dependent collisional effects are found to be marginally observable, but a systematic deviation between the theoretical calculations and the observed intensities of the higher n^3D-2^3P transitions still remains. Otherwise, the agreement between observations and calculations is within observational error. The intensities computed are used as sources in Paper II, where the modification of the triplet spectrum due to the metastability of the 2^3S state is treated. (auth)

17223 THE HELIUM TRIPLET SPECTRUM IN EXPANDING NEBULAE. II. SELF-ABSORPTION. **Robbins, R. R. (Univ. of California, Berkeley). Astrophys. J., 151: 511-29(Feb. 1968).**

The capture-cascade spectrum of the helium triplets is modified to allow for self-absorption arising from the metastability of the 2^3S level. An integral equation of transfer is formulated and solved numerically, in which planetary nebulae are assumed to be spheres of constant temperature and density, expanding with a constant velocity gradient. Line-intensity ratios as a function of T_e, optical depth in λ3889, and expansion rate are obtained. A comparison of the solutions with observed line intensities indicates that optical depths in the helium triplets are significantly larger than the values implied by earlier studies. The expansion of the nebula contributes significantly to the leakage of photons. Implied optical depths for observed planetary nebulae show reasonable agreement with 2^3S populations obtained from the collisional excitation of λ10830. The assumption of complete redistribution in the scattering is compared numerically with results obtained assuming a more exact scattering function due to Unno; significant differences between the two cases appear for optical depths between 50 and 100. The interaction of hydrogen and helium emissions at λ3889 is also investigated. Iterative methods of solving the transfer equation are considered briefly. (auth)

17224 A COMPOSITE PERIOD-LUMINOSITY RELATION FOR CEPHEIDS AT MEAN AND MAXIMUM LIGHT. **Sandage, Allan; Tammann, G. A. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 151: 531-45(Feb. 1968).**

Modern two-color data for Cepheids in the Large and Small Magellanic Clouds, M31, and NGC 6822 are combined into composite period–luminosity relations in M_B and M_V at mean and maximum light. The data are consistent with the view that the P–L relations are the same from galaxy to galaxy in both slope and zero point. The P–L relations show dispersions of ±0.60 mag in M_B and ±0.50 mag in M_V about the center line. The magnitude residuals, R_B and R_V, from the center line for individual stars, correlate well with the color residuals, $\delta(B-V)$, from the ridge line of the period–color relation. Such a correlation is expected from the theory of the Cepheid instability strip in the color–magnitude diagram. Theory and observation agree well, and this is taken as a proof that the observed dispersion in the P–L relation is primarily intrinsic. The absolute calibrations of the P–L relations are made using nine Cepheids in the galactic system whose absolute luminosities are known by photometric parallax methods. Tables of the adopted period-luminosity and period–color relations are given in the Appendix. (auth)

17225 EVOLUTION OF THE STARS AND GAS IN GALAXIES. **Tinsley, Beatrice M. (Univ. of Texas, Austin). Astrophys. J., 151: 547-65(Feb. 1968).**

A numerical computation of evolution starts from gas with Population-I composition; then stars are formed at all times, at rates which are functions of stellar mass and mass of gas in the galaxy. Discrete time steps of 10^9 years are used, and 13 stellar masses. The stars are placed on the H–R diagram according to their masses and ages; each star ends as a white dwarf, while its excess mass enriches the interstellar gas. Different evolutionary sequences are constructed by adjusting four parameters of a stellar birth-rate function. Then "galaxies" resulting from each sequence of 10 to 12 × 10^9 years are compared with observed local galaxies with respect to colors, mass-to-light ratio, relative mass of gas, and types of stars contributing to the light. "Galaxies" closely resembling all normal types, Im to E, can be formed with a stellar birth rate proportional to the inverse square of stellar mass and to the mass of gas in the galaxy; the types differ in initial rate of gas consumption and in the birth rate of very low-mass stars. These types can all have the same age, and do not form an evolutionary sequence. It is shown that giant elliptical galaxies may have been so much brighter at short wavelengths a few billion years ago that the observed magnitude–red shift relation can be interpreted in terms of cosmological models that do not suffer from the high density and small age of the conventionally preferred model. (auth)

17226 THE Li/Be RATIO IN MAIN-SEQUENCE STARS. **Conti, Peter S. (Univ. of California, Santa Cruz). Astrophys. J., 151: 567-76(Feb. 1968).**

A spectroscopic study of the Li and Be content of some bright F and G main-sequence stars has been completed. The analysis was made with newly measured equivalent widths, a curve of growth, and line strengths predicted from a grid of model atmospheres. The data are combined with previously published results. Under the reasonable assumption that stars start with a common value for the ratio Li/Be, as evidenced by spallation experiments, it is possible to trace out the pattern of Li destruction. The change of Li/Be among main-sequence stars can be interpreted as an age effect. It is found that F stars deplete Li on a time scale longer than the age of the Hyades ($t_F > 5 \times 10^8$ years). Since G stars deplete Li on a time scale shorter than this ($10^7 < t_G < 10^8$ years) there must be an inverse relation between the Li destruction rate and spectral type. Since some very old G stars still have appreciable amounts of Li, either the depletion of Li ceases before these stars leave the main sequence or Li is formed anew in subgiants. The variation of Be abundance in main-sequence stars presumably represents differences in initial light-element content. There is evidence that this initial light-element content is generally smaller in the more massive stars. Several F stars contain no detectable Be (nor Li). Unless they have destroyed these elements after arrival on the main sequence, these stars must have had little or no initial light-element content. (auth)

17227 THE MAGNETIC FIELD AND LIGHT VARIATIONS OF HD 32633. **Preston, George W.; Stepień, Kazimierz (Univ. of California, Santa Cruz). Astrophys. J., 151: 577-81(Feb. 1968).**

Concurrent UBV photometric and Zeeman spectroscopic observations of HD 32633 are used to show that the period and the ranges of the light and magnetic variations have remained approximately constant over an interval of 8 years. The coincidence of magnetic minimum and light maximum reported by Rakos is confirmed, and the possibility of a short-period variation in the radial velocity is noted. (auth)

17228 53 CAM AND THE QUESTION OF A PREFERRED PHASE RELATION BETWEEN THE LIGHT AND MAGNETIC VARIATIONS OF THE MAGNETIC STARS. **Preston, George W.; Stepien, Kazimierz (Univ. of California, Santa Cruz). Astrophys. J., 151: 583-7(Feb. 1968).**

Concurrent UBV and magnetic observations of 53 Cam are used to derive a new period and to demonstrate that the phase relation between the light and magnetic variations depends on wavelength. Phase relations for seven additional periodic magnetic stars confirm the tendency for the light and magnetic extrema to coincide in phase. The data suggest the possibility of a preference for antiphase variations of luminosity and effective magnetic field. (auth)

17229 PHOTOELECTRIC SPECTROPHOTOMETRIC OBSERVATIONS OF THE EMISSION COMPONENT OF THE Ca II K-LINE IN LATE-TYPE STARS. **Liller, William (Harvard College Observatory, Cambridge, Mass.). Astrophys. J., 151: 589-604(Feb. 1968).**

Photoelectric scans of the emission component of the K-line in the spectra of nine stars reveal that small random variations in both intensity and shape take place almost continuously. The stars α Tauri and possibly λ Andromedae exhibit greater fluctuations, sometimes of flarelike nature, with a recovery time of the order of a half-hour. No evidence of a cyclic variation has as yet been detected. (auth)

17230 LATE K- AND EARLY M-DWARF STARS IN THE HYADES. **Pesch, Peter (Case Western Reserve Univ., Cleveland). Astrophys. J., 151: 605-10(Feb. 1968).**

Spectral types based on low-dispersion, objective-prism spectra are presented for stars in the Hyades whose spectra show late-K or early-M characteristics and for which proper-motion data support cluster membership. Most of the stars fainter than $M_v \sim +9$ mag for which spectral types could be estimated are M stars, but several have color indices that are too blue for their spectral types. (auth)

17231 TEMPERATURE OF THE INNER CORONA WITH THE SUNSPOT CYCLE. **Billings, Donald E.; Hatt, William A. (Univ. of Colorado, Boulder). Astrophys. J., 151: 743-5(Feb. 1968).**

A rough determination is presented of the mean temperature of the inner corona for each solar rotation during the last sunspot cycle, based on λ5303 and λ6374 intensity observations combined with a consideration of the probability of λ5694 emission. The temperature so computed correlates strongly with mean sunspot number and 10-cm radio flux. The quantity $N_e^2T_e^{-1/2}$ does not correlate well with the 10-cm radio flux, however, which suggests that the radio noise originates lower in the solar atmosphere than the part of the corona under observation. (auth)

17232 ON THE OPTICAL POLARIZATION OF 3C 273. **Appenzeller, Immo (Univ. of Chicago). Astrophys. J., 151: 769-70(Feb. 1968).**

The polarization of 3C 273 was observed on 11 nights between March 10 and July 1, 1967. No change in the polarization could be detected during this period. The mean polarization was about 0.2 ± 0.2%. (auth)

17233 LINEAR POLARIZATION OBSERVATIONS AT 3.6-CM WAVELENGTH. **Hollinger, J. P.; Hobbs, R. W. (Naval Research Lab., Washington, D. C.). Astrophys. J., 151: 771-3 (Feb. 1968).**

The linear polarization of the radiation from sixteen discrete radio sources was observed at 3.6-cm wavelength. The observed sources include three radio variables, two with time variant linear-polarization characteristics, and three not previously observed at wavelengths as short as 3.6 cm. (auth)

17234 A RECONSIDERATION OF THE IMPORTANCE OF GRAVITY DARKENING AND OTHER EFFECTS ON STELLAR ROTATION VELOCITIES FOUND USING THE He I 4026 A LINE. **Friedjung, M. (Queen's Univ., Kingston, Ont.). Astrophys. J., 151: 779-81(Feb. 1968).**

Rotation velocities of early-type stars have been found by Slettebak (1949) using the He I 4026 Å line. In view of the fact that this gives a large amount of detail concerning the interpretation of the line profiles in terms of rotational velocities, it seemed useful to recompute the profiles without some of Slettebak's assumptions. In this investigation, line intensities were recalculated using modern model atmospheres for rotating stars, enabling gravity darkening and shape distortion to be taken into account as well as relative variations of line intensity over the disk. (W.D.M.)

17235 VARIATIONAL PRINCIPLE FOR A ONE-DIMENSIONAL STELLAR SYSTEM. **Harwit, Martin (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 151: 783-90(Feb. 1968).**

One-dimensional models have been investigated by Oort (1965), Lindblad (1959), Camm (1950), and others as an approximation to the distribution of velocity and mass normal to the galactic plane of a highly flattened galactic system. Recently Hohl and Feix (1967) have performed numerical experiments to investigate the dynamics and stability of one-dimensional stellar systems. This analysis extends the minimum energy principle obtained by Hohl and Feix to arbitrary distribution functions. (W.D.M.)

17236 EFFECTIVE TEMPERATURES AND BOLOMETRIC CORRECTIONS OF EARLY-TYPE STARS. **Morton, Donald C.; Adams, Thomas F. (Princeton Univ. Observatory, N. J.). Astrophys. J., 151: 611-21(Feb. 1968).**

New scales of effective temperatures and bolometric corrections are presented for main-sequence stars hotter than the Sun. These scales are based on model atmospheres with ultraviolet and Balmer line blanketing included where necessary. The B-type models are in reasonable agreement with the available measures of ultraviolet stellar fluxes while at A0 the visual energy distribution and Hγ profile of Vega are adequately reproduced. These scales are used to transform the observed initial main sequence and mass–luminosity law into theoretical coordinates. Model interiors agree rather well with both relations though the latter one requires a He/H ratio of 0.10 or less by number for the B and A stars. (auth)

17237 ANALYSIS OF F AND G SUBDWARFS. II. A MODEL-ATMOSPHERE ABUNDANCE ANALYSIS OF THE SUBDWARFS HD 140283 AND HD 19445. **Cohen, Judith G.; Strom, Stephen E. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard College Observatory, Cambridge, Mass.). Astrophys. J., 151: 623-36(Feb. 1968).**

A grid of model atmospheres was used to perform an abundance analysis of these two extreme Population-II stars. The abundances determined from the models confirm the general results of previous investigations, namely that metals are deficient by a factor of about 100 relative to average Population-I abundances. A marginal deficiency of s-process material relative to the average deficiency is found; the carbon deficiencies are comparable to those of the other elements and for HD 19445 the α-process elements are enhanced. From the analysis it also appears that convection plays a significant role in determining the temperature structure of subdwarf atmospheres. (auth)

17238 GLOBAL RADIATION EMERGING FROM A RAYLEIGH-SCATTERING ATMOSPHERE OF LARGE OPTICAL THICKNESS. **Kahle, Anne B. (Rand Corp., Santa Monica, Calif.). Astrophys. J., 151: 637-45(Feb. 1968).**

The global radiation, which includes the diffuse sky and attenuated solar radiation emerging downward and the diffuse sky radiation emerging upward from a plane-parallel Rayleigh-scattering atmosphere, is determined. Using Mullikin's and Sckera's modifications of Chandrasekhar's radiative transfer theory, earlier work is extended to include atmospheres of large optical thickness. Effects of varying solar zenith distance and ground reflectivity according to Lambert's law are determined. The possible values of Bond albedo for planets with these idealized properties are found. (auth)

17239 EQUILIBRIUM PROPERTIES OF MATTER AT VERY HIGH TEMPERATURES AND DENSITIES. **McKee, Christopher F. (Univ. of California, Berkeley). Astrophys. J., 151: 647-58 (Feb. 1968).**

The problem of determining the composition, pressure, and energy density of matter at temperatures of the order of 0.5 MeV or greater, which arises in supernova calculations and in studies of the early phases of the Universe, is solved in the case of weak interaction equilibrium—i.e., the neutrinos are coupled to the rest of the matter and a steady-state condition exists. The solution is obtained in that part of the $\rho_b - T$ (baryon density, temperature) plane in which the following conditions are satisfied: the gas is ideal, the electrons are extreme relativistic, and nuclei heavier than He^4 are negligible. Analysis of the effect of strong interactions indicates that the gas may be considered ideal (to within 20%) up to a baryon density ranging from 5×10^{12} g/cm^3 at T = 5 MeV to 5×10^{13} g/cm^3 at T = 150 MeV; baryon pair production is shown to set an upper limit of T ≈ 150 MeV (independent of density) beyond which the gas is not ideal. An approximate analytic solution is obtained which is valid in most of the region of the $\rho_b - T$ plane described above. This solution takes into account all baryons of baryon number 1, and all leptons and mesons; it specifically includes hyperons and strongly decaying resonances (which begin to be significant at about T = 50 MeV) and antibaryons. The results of a computer solution are presented for the high-density region in which the analytic solution breaks down. (auth)

17240 OPTICAL APPEARANCE OF A STAR THAT IS COLLAPSING THROUGH ITS GRAVITATIONAL RADIUS. **Ames, William L.; Thorne, Kip S. (California Inst. of Tech., Pasadena). Astrophys. J., 151: 659-70(Feb. 1968).**

An analysis is presented of the radiation received by a distant observer viewing the late stages of gravitational collapse of a nonrotating, spherically symmetric star. The spectral distribution is calculated as a function of time and of position on the apparent disk of the star; and the spectral properties of the total integrated radiation are discussed. Among the conclusions are these: the star is brightest and bluest at its rim, where the spectrum and the intensity are independent of time; but the width of this time-independent region decays exponentially. Nearer the center of its disk, the star appears darker and redder; the red shift increases exponentially in time, and the intensity decays exponentially. The total, integrated radiation is dominated by the contribution from the rim: the spectrum is nearly time-independent and is peaked at its high-frequency end; but the total luminosity decays exponentially with time. (auth)

17241 ESTIMATE OF THE ENHANCEMENT OF DYNAMICAL FRICTION BY STELLAR CO-OPERATIVE EFFECTS. **Thorne, Richard M. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 151: 671-7(Feb. 1968).**

The dynamical friction experienced by a massive particle traveling within a thin, differentially rotating disk of stars with a small epicyclic motion in addition to the equilibrium rotation of the stars in its vicinity is considered. The collective interactions among the stars themselves are included in this analysis, and are found at most to double that friction in typical circumstances. For an object such as an interstellar "cloud complex" of mass M moving in a not quite circular orbit in our vicinity of the Galaxy, the present analysis shows the damping time of its epicyclic motion to be approximately $(M_\odot/M) \times 10^{15}$ years. (auth)

17242 TIME OF RELAXATION. I. UNBOUNDED MEDIUM. **Ostriker, J. P.; Davidsen, Arthur F. (Princeton Univ. Observatory, N. J.). Astrophys. J., 151: 679-86(Feb. 1968).**

The classical problem of relaxation time in an infinite, uniform, stellar medium is reinvestigated by a method that includes the time dependence of interactions, in contrast to the original treatment in which all collisions were considered to be very brief. The calculation follows interactions between pairs of stars proceeding along their orbits from various specified initial conditions, and then averages over these initial conditions. In agreement with the work of Henon and Prigogine, it is found that no divergence arises from the integration over large impact parameters. It is also found that no error is introduced into the dominant term of the expression for relaxation time if the integration is performed over the unperturbed orbit, so long as the closest collisions are omitted. The resulting formula for relaxation time agrees well with Chandrasekhar's formula except that no cutoff distance is introduced. (auth)

17243 BROWNIAN MOTION IN A STELLAR SYSTEM. **Lee, Edward P. (Univ. of Chicago). Astrophys. J., 151: 687-97 (Feb. 1968).**

The random motion of a star in phase space is examined using the autocorrelation function of the random force acting on the star. In this framework the long "memory" of weak forces leads to a divergent expression for the mean square velocity increment of the star. It is shown that this expression is equivalent to one obtained by summing independently the effects of complete encounters. A procedure of summing velocity increments is developed and extended to include distant encounters. The transition probability is found and is used to examine the validity of the Fokker–Planck equation. (auth)

17244 STELLAR DYNAMICS IN A DISCRETE PHASE SPACE. **Miller, R. H. (Univ. of Chicago); Prendergast, K. H. Astrophys. J., 151: 699-709(Feb. 1968).**

A new approach to numerical experiments with self-gravitating stellar dynamical systems is described that permits enough bodies to be included to make the problem interesting. The forces are obtained by solving the Poisson equation at each integration step. The method incorporates the essential physical features of collision-free systems exactly and appears to be adaptable to a wide class of initial value or self-consistency problems. Stellar systems of 120,000 particles have been followed; preliminary results are given. (auth)

17245 ENERGETIC SOLAR FLARE X-RAYS OBSERVED BY SATELLITE AND THEIR CORRELATION WITH SOLAR RADIO AND ENERGETIC PARTICLE EMISSION. **Arnoldy, R. L.; Kane, S. R.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). Astrophys. J., 151: 711-36(Feb. 1968).**

Ionization chambers aboard the OGO-A and OGO-B spacecrafts with a response window for x rays between 10 and 50 keV have accumulated more than 6000 hours of operation in space outside Earth's magnetosphere. Approximately thirty solar flare x-ray bursts have been detected between September 5, 1964, and June 20, 1966. These energetic x-ray bursts have been correlated with 3- and 10-cm solar radio emission and solar-flare electron and proton events measured in space. A proportionality is observed between the time-integrated x-ray and radio fluxes, and for a given flare the rise time, decay time, and total duration of the radio and x-ray bursts are similar. Exponential time constants between 1 and 10 min characterize the decay. All 3- or 10-cm radio bursts greater than 80 flux units are accompanied by an x-ray event greater than 3×10^{-7} ergs cm^{-2} sec^{-1}, and the probability of detecting an x-ray event is negligible unless the radio spectrum includes the centrimetric range of wavelengths. All but three of the x-ray events were correlated with SWF ionospheric disturbances. A number of large flare events occurred in which all of the energetic processes were observed; namely, solar protons, solar electrons, energetic bremsstrahlung, and high-frequency radio emission. In comparing energetic x rays with solar particle emission the best correlation seems to exist with the solar electron events observed in space. Many solar proton events occurred without a detectable burst of energetic x rays. It is shown that the results are consistent with a source in the flare region consisting of an active volume in a magnetic field containing hot or energetic electrons which lose energy predominantly by collisions with a much cooler gas and produce x rays by bremsstrahlung. The similarity of decay and proportionality between the x rays and microwaves suggests that the same electrons might produce both emissions. About 5×10^{-54} joules m^{-2} $(c/s)^{-1}$ of microwave energy at Earth are required per electron at the Sun on the average. Physically acceptable choices of electron energy, collisional limited lifetime, and magnetic field strength exist such that, with the assumption of synchrotron emission for the microwave radiation and bremsstrahlung for the x rays, the observed proportionality between the two can be met. A thermal source for the radio emission cannot, however, be excluded. (auth)

17246 RELATIVISTIC MAGNETOHYDRODYNAMICS. **Scargle, Jeffrey D. (California Inst. of Tech., Pasadena). Astrophys. J., 151: 791-5(Feb. 1968).**

The hydrodynamic description of a relativistic gas in a magnetic field is discussed, using the method of Chew, Goldberger, and Low. The energy–momentum tensor is evaluated. (auth)

17247 THE STELLAR RATES OF THE $^{13}C(\alpha,n)^{16}O$ AND $^{9}Be(\alpha,n)^{12}C$ REACTIONS. Davids, Cary N. (California Inst. of Tech., Pasadena). Astrophys. J., 151: 775-8(Feb. 1968).

Greenstein (1954) and Cameron (1954) proposed the $^{13}C(\alpha,n)^{16}O$ reaction as a source of stellar neutrons. This note presents results of measurements made of the thick-target neutron yield from this reaction. The yield was determined for lab energies between .363 and 0.535 MeV. Results are also presented of measurements carried out on the reaction $^{9}Be(\alpha,n)^{12}C$, taken with a thin target, at 0.340 to 0.680 MeV. (W.D.M.)

17248 COSMIC BLACK-BODY RADIATION AND GALAXY FORMATION. **Silk, Joseph (Harvard College Observatory, Cambridge, Mass.). Astrophys. J., 151: 459-71(Feb. 1968).**

The possibility is examined that galaxies may have formed from an initial spectrum of primordial fluctuations of small amplitude (although not necessarily of small scale). With a cosmological interpretation of the 3°K microwave backgound radiation, it is found that fluctuations containing more than 10^{-4} M⊙, but less than a certain critical size, would be optically thick at an epoch subsequent to the primordial fireball (i.e., $T < 10^{10}$°K), and would be damped out by radiative diffusion on a time scale short compared to the expansion time. This critical size corresponds to the mass of a typical galaxy, and is of the order of 10^{11} M⊙. The survival of primordial fluctuations to an epoch when galaxy formation may occur is found to imply an angular anisotropy in the 3°K radiation of between approximately 10 and 30″, depending on the mean value taken for the present density of matter in the Universe. An upper limit is also derived on the mass of a gravitationally bound condensation by considering the destabilizing tendency of the radiation. A consequence of this result is that any large-scale (≳100 Mpc) anisotropy in the Universe would be consistent with a value for the mean density of matter at the present epoch of only about 10^{-30} g/cm^3 or less. (auth)

17249 ISOTROPY OF THE UNIVERSE. **Misner, Charles W. (Peterhouse, Cambridge, Eng.). Astrophys. J., 151: 431-57 (Feb. 1968).**

Solutions of the Einstein equations with flat homogeneous spacelike hypersurfaces but anisotropic expansion rates are given in which the effects of viscosity in the radiation, and of anisotropic pressures from collisionless radiation are included. These show that the present anisotropy of the black-body photon temperature should be less than 0.03%, independent of the amount of initial anisotropy, if the Universe has cooled to its present state from temperatures above about 2×10^{10}°K. (auth)

17250 OBSERVATIONAL EVIDENCE CONCERNING THE gf-VALUES OF Si II λ4128 AND λ4130 A. Underhill, Anne B. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Astrophys. J., 151: 765-8(Feb. 1968).

A comparison of the strengths of the Si II lines in model atmospheres and in B stars is reported. The lines λ4128 and λ4130 are observed to be weaker by a significant factor than the values predicted with the best available theoretical gf-values. (auth)

17251 PROBABLE AGES OF THE OLDEST OPEN CLUSTERS. **King, Ivan R. (Univ. of California, Berkeley). Astrophys. J., 151: L59-60(Feb. 1968).**

A priori statistical arguments suggest that the oldest open cluster known at present should be about half as old as the galactic disk. (auth)

17252 THERMAL EMISSION BY PARTICLES IN NGC 7027. **Krishina Swamy, K. S. (Goddard Space Flight Center, Greenbelt, Md.); O'Dell, C. R. Astrophys. J., 151: L61-6(Feb. 1968).**

It is shown that the strong infrared continuum in the planetary nebula NGC 7027 can be quantitatively understood in terms of emission from particles within the nebula. Calculations for graphite flakes match the observations very well, although this argument does not preclude other particles having infrared absorptivities similar to graphite. The infrared energy arises from the absorption of nebular Lyman-α photons, the intensity of which is calculated, with rather good agreement for both the frequency distribution and the expected level of the infrared emission. Other effects due to the presence of particles in the planetary nebulae are discussed. (auth)

17253 ON THE INFRARED MEASUREMENTS FROM A NEBULA IN ORION. **Pottasch, S. R. (Kapteyn Astronomical Lab., Groningen, Netherlands). Astrophys. J., 151: L67-8(Feb. 1968).**

Recently, Kleinmann and Low (1967), observing in the wavelength region between 17.5 and 25 μ in the infrared, discovered an extended source of dimensions somewhat greater than 30 in. The source is located in the direction of Orion, and the measured flux density in the above wavelength region is 5×10^{-15} W cm^{-2} μ^{-1}, or a total flux density of 3 to 4×10^{-14} W cm^{-2}. They interpret this as due to the radiation from an interstellar cloud which is optically thick. The opacity is due to interstellar grains. Since the cloud is assumed optically thick, it is also assumed to radiate as a black body, and it is found that a balck-body temperature of 70°K for this cloud is sufficient to produce the observed radiation. Such a temperature is consistent with temperatures otherwise computed or measured in the neutral interstellar gas. The weakest part of the above argument is the assumption that the cloud is optically deep because of the grains. In this letter it is pointed out that a very different explanation of the observed radiation is possible, which does not rely on the radiation by the dust grains. (W.D.M.)

17254 PHOTOMETRY OF MHα 328-116. Philip, A. G. Davis (State Univ. of New York, Albany. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 151: L69-71(Feb. 1968).

UBV and four-color photometry is presented for the star MHα 328-116. Since September 1965, this star has become redder and brighter in UBV photometry. In four-color photometry the b−y index is steadily becoming more negative. (auth)

17255 THE RADIO POSITION OF THE SOURCE OA 33. Hogg, D. E.; Roberts, M. S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 151: L73(Feb. 1968).

In order to assist the process of indentification, a radio position for OA 33 was measured with the three-element interferometer of the NRAO. The position at 2695 MHz, using the method described by Wade, Clark, and Hogg (1965), is $\alpha = 00^{h}35^{m}41.3^{s} \pm 0.2^{s}$, $\delta = +41°20'37'' \pm 2''$ (1950.0). (W.D.M.)

17256 OPTICAL POSITIONS FOR TWENTY-SIX RADIO SOURCES. Lu, Phillip K.; Fredrick, Laurence W. (Univ. of Virginia, Charlottesville). Astrophys. J., 151: L75-7(Feb. 1968).

Optical positions are listed for twenty-six radio sources given primarily in the Parkes catalogue. The nucleus of NGC 1052 is suspected of having a small jet associated with it. The present identification of 0222−23 must be in error, and a restudy to locate the true optical source would be useful. (auth)

17257 THE UNUSUAL LONG-TERM BEHAVIOR OF 3C 371. Usher, Peter D.; Manley, Oscar P. (American Science and Engineering, Cambridge, Mass.). Astrophys. J., 151: L79-82 (Feb. 1968).

The Harvard plate collection was examined for the brightness history of 3C 371. A long-term brightness fluctuation of amplitude about 1.5 mag over a period of seventy years was found. This amplitude is much larger than that observed in the quasar 3C 273. Superimposed on the long-term behavior of 3C 371, brightness changes of about 0.5 mag were found, with a time scale of several months, which are similar to the brightness increase reported by Oke and observed independently by Sandage (1967). Particulars concerning the data and a discussion of their physical significance are presented. (W.D.M.)

17258 NATURE OF SOME GALACTIC X-RAY SOURCES. Prendergast, K. H. (Columbia Univ., N. Y.); Burbidge, G. R. Astrophys. J., 151: L83-8(Feb. 1968).

A model to explain the generation of x-ray sources in close binary systems is described. It is concluded that models of this type may be able to account for the x-ray flux emitted by Sco X-1 and Cyg X-2. (auth)

17259 INTERSTELLAR REDDENING IN THE FIELD OF CYG X-2. Cathey, Larry R.; Hayes, James E. (Univ. of California, Santa Cruz). Astrophys. J., 151: L89-92(Feb. 1968).

Measurements of colors and magnitudes of a large number of stars in the field of Cyg X-2 are reported. From these observations it was possible to construct a diagram of the variation of color excess with distance. (W.D.M.)

17260 THE 18-CM FLUX OF THE UNRESOLVED COMPONENT OF 3C 273. Moran, J. M. (Massachusetts Inst. of Tech., Cambridge); Burke, B. F.; Barrett, A. H.; Rogers, A. E. E.; Carter, J. C.; Ball, J. A.; Cudaback, D. D. Astrophys. J., 151: L99-101(Feb. 1968).

Using an interferometer with elements spaced at 19.5×10^{6} λ at 18-cm wavelength, the fringe amplitude of 3C 273B was found to be 0.6 ± 0.2. This is interpreted to mean that the source has an unresolved feature of size less than 0.″005 having a flux of $14 \pm 4 \times 10^{-26}$ W m^{-2} (c/s)$^{-1}$. (auth)

17261 PHOTOELECTRIC SCANNER SPECTROPHOTOMETRY OF CYG X-2. Peimbert, M. (Univ. of California, Berkeley); Spinrad, H.; Taylor, B. J.; Johnson, H. M. Astrophys. J., 151: L93-7(Feb. 1968).

On October 27, 1967, centered at 4-0 UT, observations of the x-ray source Cyg X-2 were made with the Wampler scanner at the Lick 120-inch telescope. Standard extinction by Wampler (1967) and the energy distribution by Hayes (1967) for 58 Aql were used to reduce the data. (W.D.M.)

17262 EXPERIMENTAL METHOD FOR TESTING NUMERICAL STABILITY IN INITIAL-VALUE PROBLEMS. Miller, Richard H. (Univ. of Chicago). Contract AT(11-1)-614. J. Comput. Phys., 2: 1-7(Aug. 1967).

The numerical stability of evolutionary calculations can be tested experimentally by running two calculations in parallel, starting from initial conditions that are very similar, and monitoring the differences between the systems. An integration of an n-body system with gravitational interactions provides an example that is useful for illustrative purposes. Some features of the method are described, followed by a discussion of some considerations in its application. (auth)

17263 CURVE-OF-GROWTH ANALYSIS OF THE SPECTRUM OF ARCTURUS. Griffin, R.; Griffin, R. Mon. Notic. Roy. Astron. Soc., 137: 253-69(1967).

The spectrum of the K2 giant star Arcturus was investigated at very high dispersion in the region λλ 5000 to 7025 Å from coudé spectrograms secured at the 100-inch Mount Wilson telescope. The plates had reciprocal dispersions of approximately 1 to 1.6 Å/mm. Absolute curves of growth were constructed for neutral and ionized elements and yield θ_{exc} = 1.37 for Ti I, 1.27 for Fe I, and 1.20 for ions. Differential curves of growth constructed with respect to the Sun yield $\Delta\theta_{exc}$ = 0.36 for Ti I and 0.24 for Fe I, and elements in Arcturus are found to be deficient by a factor of 3 relative to hydrogen. The ratio of spectroscopic surface gravities, $g_{\odot} = 500\ g_{\alpha}$, leads to the mass ratio $M_{\alpha} = 1.2M_{\odot}$. A similar differential analysis of Arcturus with respect to the G8 giant star ε Vir, which has solar composition, confirmed the metal deficiency in Arcturus. The analyses established that $\Delta\theta_{exc}$ for ionized lines is considerably smaller than $\Delta\theta_{exc}$ for neutral lines. The spectroscopic surface gravity for Arcturus is found to be smaller by a factor of 10 or more than the figure generally quoted for normal giants. (auth)(UK)

17264 METEORITES AS DOCUMENTS OF EXTRATERRESTRIAL EVENTS AND COSMIC RADIATION. Hecht, Friedrich. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. II, 175: 271-92(1966). (In German).

The nature and orbits of meteorites are outlined. The nuclear chemistry of meteorites and the calculation of the radiation age are discussed. The use of depth effects to determine the preatmospheric constitution of meteorites is outlined. The formation of meteorites and their terrestrial age are discussed. Tritium production in artificial earth satellites is described. (J.S.R.)

17265 SPECTRAL AND LOCATION MEASUREMENTS OF SEVERAL COSMIC X-RAY SOURCES INCLUDING A VARIABLE SOURCE IN CENTAURUS. Chodil, G. (Univ. of California, Livermore); Mark, Hans; Rodrigues, R.; Seward, F.; Swift, C. D.; Hiltner, W. A.; Wallerstein, George; Mannery, Edward J. Contract W-7405-eng-48. Phys. Rev. Lett., 19: 681-3(Sept. 11, 1967). (UCRL-70538).

This paper reports the results of x-ray spectrum and location measurements of several cosmic x-ray sources made on May 18, 1967. Rocket-borne proportional counters were used. The x-ray spectra of Sco X-1, Tau X-1, and Lup X-1 were measured, and the location of Vel X-1, Lup X-1, and a new source Cen X-3 were determined. In addition, the x-ray spectrum and location of a variable source, Cen X-2, were obtained. (auth)

17266 COORDINATE STRETCHING AND INTERFACE LOCATION. I. STAR MODELS IN QUASI-STATIC EQUILIBRIUM. Usher, Peter D. (Harvard Coll., Cambridge, Mass.). Contract 19(628)-3877. J. Comput. Phys., 2: 8-11(Aug. 1967).

The use of the coordinate stretching procedure of Poincaré and Lighthill is investigated for its applicability to the question of interface location in two-point boundary-value problems. The case in which an interface separates zones of convective and radiative equilibrium in star models is used to exemplify the technique. The necessary conditions for choosing the arbitrary Poincaré−Lighthill function are discussed briefly, and the linearized problem is formulated by making a particular choice for the function. (auth)

17267 ELEVEN-YEAR CYCLE OF SOLAR FLARES AND GEOMAGNETIC CROCHETS. Pinter, S. (Geophysical Inst., Slovak Academy of Sciences, Hurbanovo, Czechoslovakia); Knoska, S. Bull. Astron. Inst. Czech., 19: 40-2(1968).

Investigated, in ample material, was the occurrence (F_p) of solar flares and that of geomagnetic crochets in the latest cycle of solar activity. The curves of index F_p and of the occurrence of geomagnetic crochets agree well over the 11-year cycle. It is seen that the 11-year curve of index F_p is superimposed by yearly variation with a maximum in August and September, and a minimum in January. Certain concepts of the occurrence of geomagnetic crochets in connection with flares were re-evaluated. (auth)

17268 DISTANCES OF FILAMENT FEET. Sykora, J. (Astronomical Inst., Slovak Academy of Sciences, Skalnate Pleso). Bull. Astron. Inst. Czech., 19: 37-9(1968).

The histograms of frequency of the distances of filament feet show two distinct maxima (26,000 km and 47,500 km). An attempt was made to divide the filaments into two groups: "quiescent" Q and "active" A. The maxima for A filaments belong to distances 1500 to 3500 km smaller than for Q filaments. A probable change of distances of the filament feet with the solar cycle was found. The arrangement of the supergranulation network is discussed in relation to maxima of frequency of the distances of filament feet on the histograms. (auth)

17269 COMPLETE SYSTEM OF EQUATIONS FOR NON-SYMMETRIC PROBLEMS IN GENERAL RELATIVITY. Pachner, J. (Astronomical Inst., Czechoslovak Academy of Sciences, Prague). Bull. Astron. Inst. Czech., 19: 33-7(1968).

Assuming co-moving coordinates, a complete system of 13 equations describing the behavior of a perfect fluid is put together. It is then reduced to a system of 9 differential equations which must be satisfied by 10 components of the metric tensor $g_{\mu\nu}$. Imposing a reasonable condition on the component g_{44}, which can be satisfied without any loss of generality, the integration of 3 equations can be carried out exactly giving explicit expressions for g_{i4}. The remaining 6 components $g_{ik}(i,k = 1, 2, 3)$ are determined by 6 independent Einstein field equations. (auth)

17270 EVOLUTION OF CLOSE BINARIES. I. TWO EXAMPLES OF MASS EXCHANGE IN PHASE I. Plavec, M.; Kriz, S.; Harmanec, P.; Horn, J. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 19: 24-33(1968).

A study was made of the evolution of two close binaries at the phase when the more massive star during its expansion fills its critical Roche lobe and begins to lose mass. Initial conditions were chosen so that the Roche limit is attained by the more massive component at the evolutionary period when it burns hydrogen in its convective core and expands slowly, moving at the same time to the right of the zero-age main sequence in the H–R diagram. This phase of expansion was called "Phase I" by Plavec (1968) or "Fall A" by Kippenhahn and Weigert (1967). It is assumed that all the mass lost by the original primary is transferred to the other component, so that the total mass and the total orbital angular momentum of the system are preserved. The calculations were made by Henyey's method; certain aspects of the computational techniques are mentioned. In the system of $7\ M_\odot + 5\ M_\odot$, the original primary (i.e., more massive) component loses $2.9\ M_\odot$ within 126,000 years, and the roles of the components are interchanged. A long phase of prolonged but very slow mass loss follows, with a duration of at least 1.6×10^6 years. During this period the original primary can be identified with the observed secondary components in some Algol-like systems like Z Vul or V 356 Sgr: it is overluminous for its mass, its spectral type is B 9.5 II–III, and it is superficially unstable, because it continues to fill its critical Roche lobe. In the system $9\ M_\odot + 8\ M_\odot$ the original primary loses $2.4\ M_\odot$ within 200,000 years; again a long period (at least 2.5×10^6 years) follows of very slow mass loss, when the star continues to fill its critical Roche lobe. At this period, it is a B5 III giant, overluminous for its mass. The mass of the other component is now $11.6\ M_\odot$, i.e., the roles of the components are interchanged. A comparison of this result with the one obtained by Kippenhahn and Weigert (1967) for $9\ M_\odot + 5\ M_\odot$, shows that the process of mass exchange is slower and less material is exchanged when the difference in the original masses of the components is smaller. Therefore the initial mass ratio affects considerably the process and the final outcome of mass exchange. (auth)

17271 ON THE BALMER EMISSION LINES IN RW TAURI. Plavec, M. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 19: 11-24 (1968).

An attempt was made to obtain some quantitative information about the physical properties of the gaseous ring in RW Tauri from its emission lines. On a spectrogram obtained by A. H. Joy in 1943, equivalent widths of the Balmer lines H8 to H19 were measured. The Balmer decrement is quite slow and similar to some Be stars. A geometrical model of the gaseous ring is constructed, and Sobolev's theory of moving envelopes is applied in order to derive the distribution of the hydrogen atoms into the higher energy levels. Only rough values can be obtained because of the low dispersion of the spectrogram. More definite numbers can be obtained if the populations n_k are compared with that of the 8th level. It is hoped to use these results in a forthcoming discussion based on the solution of Sobolev's equations. (auth)

17272 MORPHOLOGICAL STUDY OF PLANETARY NEBULAE. I. OBSERVED FORMS OF PLANETARY NEBULAE. Khromov, G. S. (Sternberg State Astronomical Inst., Moscow); Kohoutek, L. Bull. Astron. Inst. Czech., 19: 1-11(1968).

A new system of the classification of observed forms of planetary nebulae is proposed. The system is based upon the supposition that in a given nebula one can distinguish a bright compact "main structure" and a relatively fainter elongated "peripherical structure," which envelopes the former one. The classification involves as well a set of simple geometric characteristics of the image of the nebulae. With the aid of the system described the vast photographic material used initially in the preparation of "Catalogue of Galactic Planetary Nebulae" (L. Perek and L. Kohoutek, 1967) was studied. The total number of objects classified is 263: 80 in Type 1, 84 in Type 2, and 99 in Type 3. The system of classification has turned out to be flexible enough; it has been possible to classify about 90% of the objects, with the structure resolved. (auth)

17273 OBSERVATION OF A RAPIDLY PULSATING RADIO SOURCE. Hewish, A.; Bell, S. J.; Pilkington, J. D. H.; Scott, P. F.; Collins, R. A. (Cambridge Univ., Eng.). Nature (London), 217: 709-13(Feb. 24, 1968).

Unusual signals from pulsating radio sources have been recorded at the Mullard Radio Astronomy Observatory at the Cavendish Laboratory. The radiation appears to come from local objects within the galaxy, and may be associated with oscillations of white dwarf or neutron stars. (auth) (UK)

17274 BILDERBERG MODEL OF THE PHOTOSPHERE AND LOW CHROMOSPHERE. Gingerich, O. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); De Jager, C. Solar Phys., 3: 5-25(Jan. 1968).

From 17 through 21 April 1967, an international study week was held in the "Bilderberg" near Arnhem, Netherlands, with the aim of obtaining an internationally acceptable model of the solar photosphere and low chromosphere. It was found that such a model, based on observed intensities and center-to-limb observations of the solar continuous spectrum, could indeed be established. This model, henceforth called the Bilderberg Continuum Atmosphere (BCA), is shown and the temperature, gas and electron pressures, and other data are given as functions of the continuous optical depth at 5000 Å between $\tau_{5000} = 10^{-7}$ and 25. The model is characterized by a flat temperature minimum of 4600°K between $\tau_{5000} \approx 10^{-2}$ to 10^{-4}. The model is homogeneous, and in hydrostatic equilibrium. A hydrogen–helium ratio of 10 has been assumed. Much divergence remains in the interpretation of line-profile observations with regard to the establishment of a photospheric model. It proved to be as yet impossible to obtain reliable information on the variation with depth of the following functions: temperature fluctuations, turbulence velocities, convective velocities, and vibrational velocity amplitudes. Provisionally, it is assumed that $\nu_{\text{macro}} = 2$ km/sec and $\nu_{\text{micro}} = 1$ km/sec, isotropic and independent of depth. (auth)

17275 CONTRIBUTION TO A STUDY OF THE SOLAR SPECTRUM OF HYDROGEN. Cuny, Y. (Observatoire, Paris). Solar Phys., 3: 204-40(Jan. 1968). (In French).

The continuous and line spectrum of hydrogen emitted by the Sun is computed, taking deviations of local thermal equilibrium into account. The theory of line formation as given by Jefferies and Thomas was applied to the computations; a comparison of the these results with the observations gives information on the solar atmospheric model. The energy emitted by Lyman α was computed for a two- and three-level atom; it appears to increase slightly with the number of levels. The energies, computed with the HAO model and the model of Coates, are larger than the observed values. The core of the Lyman-α profile is determined by collisions; the peaks are formed at a height where the electron temperature is about 20,000°K; the energy depends very strongly on the electron density of the model. It is shown that the profile of Lyman β only shows a central self reversal if the model of the high chromosphere has a temperature plateau. An interpretation of the observed distance of the peaks of the Lyman-α and Lyman-β line profiles is possible; it can also be shown why the distance of the Lyman-α peaks to the line center is always of the order of 0.2 Å. The residual central intensity of Hα increases slightly with the number of atomic levels; the value computed with a five level atom, with the HAO chromospheric model, and the Utrecht photospheric model (1964) does not differ very much from the observed value: it is slightly smaller than the observed value and the computed profile is narrower than the observed profile. In the case of the HAO model the source function of Hα is dominated by the photo-ionization terms; nevertheless, the collision terms are not much smaller than the photo-ionization terms; the residual central intensity of Hα computed with a chromospheric model similar to the interspicular model of Athay and Thomas but assuming a higher electron temperature and density is larger than the observed value. (auth)

17276 EMISSION CORES IN H AND K LINES. I. THE OPTICALLY THICK CHROMOSPHERE. Athay, R. Grant; Skumanich, A. (High Altitude Observatory, Boulder, Colo.). Solar Phys., 3: 181-203(Jan. 1968).

Profiles of the H and K lines of $\mathrm{Mg_{II}}$ and the K line of $\mathrm{Ca_{II}}$ are computed using a two-level atom for five model atmospheres distinguished from each other mainly by the location of the temperature minimum. In the five models the temperature minimum and the chromospheric temperature are adjusted to give best agreement between computed and observed profiles. The parameters ϵ and r_0 are prescribed as functions of τ from a density model of the atmosphere. By comparing computed and observed profiles of the K_3, K_2, and inner K_1 components of the lines both the approximate depth variation of $\Delta\lambda_D$ and the best of the temperature models are determined. It is found that the Doppler width increases rapidly with height in the chromosphere beginning from a value of 1.6 km/sec at $\tau_c \approx 10^{-2}$. This latter value corresponds closely to the thermal velocity of Mg atoms in the upper photosphere. The preferred temperature model is one for which the temperature minimum occurs near $\tau_c(\lambda 2800) \approx 10^{-4}$ to 10^{-5} with a value $T_{min} \lesssim 4200°$ and which has a temperature near 7000° at $\tau_c = 10^{-6}$ where K_2 is formed. The intensity in K_2 is determined largely by $d\Delta\lambda_D/d\tau$ in the K_2 and K_3 regions. (auth)

17277 THE SOLAR H AND K LINES OF IONIZED CALCIUM. Zirker, J. B. (Univ. of Hawaii, Honolulu). Solar Phys., 3: 164-80(Jan. 1968).

Photographic observations of the mean H and K profiles are given for several positions across the solar disk ($0.1 < \mu < .6$). The core profiles of H and K are nearly identical at the same position on the Sun. Estimates of the mean Doppler width and the depth of formation of the K_2 emission peaks are given. A more elaborate analysis confirms that the K_2 peaks are formed in a relatively shallow layer ($\tau_0 \sim 3$) in which the Doppler width decreases rapidly inward. The relevance of these conclusions to current attempts to predict theoretically the H and K profiles is discussed. (auth)

17278 SOURCE FUNCTIONS IN THE CORES OF INFRARED FRAUNHOFER LINES. De Jager, C. (Univ., Utrecht); Neven, L. Solar Phys., 3: 159-63(Jan. 1968).

If the profiles of all Fraunhofer lines were formed according to the mechanism of pure absorption, the source functions $S_\lambda(\tau)$ deduced empirically from the central intensities of these lines should all be identical, and equal to the black-body function $B_\lambda(\tau)$. In order to examine this hypothesis the source functions were deduced empirically according to a method applied earlier for some twenty infrared lines for which accurate center-to-limb observations were available. The lines belonged to five different multiplets. (W.D.M.)

17279 CENTER-LIMB BEHAVIOR OF SOLAR MOLECULAR LINES. Withbroe, George L. (Harvard Coll., Cambridge, Mass.). Solar Phys., 3: 146-58(Jan. 1968).

The center-limb behavior of C_2, CH, CN, CO, and MgH lines were analyzed using five photospheric models. A three-stream model developed by Elste gave the most satisfactory results, providing evidence for the existence of inhomogeneities in the photospheric layers $-2.5 \leq \log \tau_{5000} \leq -0.5$. (auth)

17280 CENTER-TO-LIMB ANALYSIS OF THE SOLAR OXYGEN LINES. Muller, Edith A. (Observatoire, Geneva); Baschek, Bodo; Holweger, Hartmut. Solar Phys., 3: 125-45 (Jan. 1968).

Several lines of neutral oxygen observed at various positions on the solar disk were used to study the influence of (1) the temperature distribution, (2) the velocity field, and (3) the damping on the line profiles and the abundance of oxygen in the photosphere. Theoretical profiles were calculated on the basis of four different model atmospheres in LTE. It was found that the model proposed by Holweger (1967) best reproduced the center-to-limb observations of the lines studied. The weighted mean of the oxygen abundance turned out to be $\log \epsilon_O = 8.83$ on the basis of $\log \epsilon_H = 12.00$. (auth)

17281 SIMPLIFIED MODEL SOLAR ATMOSPHERE. Lambert, D. L. (Oxford Univ.). Solar Phys., 3: 118-24(Jan. 1968).

A simplified representation of the temperature distribution in the solar photosphere is proposed: $\theta(\tau_0) = \theta_0 - \theta_1 \log \tau_0$. An expression is derived for the emergent continuous spectrum from the simple model. The limitations and applications of the simple model are discussed. (auth)

17282 COMMENTS ON THE BILDERBERG CONTINUUM ATMOSPHERE. Elste, Gunther (Univ. of Michigan, Ann Arbor). Contract N(onr)-1224(19). Solar Phys., 3: 106-17(Jan. 1968).

The Bilderberg Continuum Atmosphere fails to reproduce the observed limb darkening throughout the range of wavelengths 4500 Å < λ < 25000 Å. The temperature-pressure diagram for the deep layers of this model is a curve which is flatter than the relation predicted from the mixing-length theory. A modification of the Bilderberg Continuum Atmosphere that improves representation of the observations and theoretical results is proposed. (auth)

17283 THE SOLAR CONTINUUM FROM 900 TO 130,000 A AND THE PHOTOSPHERIC TEMPERATURE MODEL. Sauval, A. (Royal Belgian Observatory, Brussels). Solar Phys., 3: 89-105 (Jan. 1968).

In order to obtain a better agreement between observed and computed values of the solar intensity, an improved temperature distribution is deduced for the range $0.02 < \tau_0 < 10$. The intensity observations considered refer to the wavelength region between λ 1980 and λ 129,500, and the center-limb variations generally go down to $\cos \theta = 0.1$. The improved model differs rather little from the Utrecht 1964 model, used here as a reference. It appears necessary to introduce an empirical correction function to be applied to the continuous absorption coefficient. This function was derived for the spectral region between 2,000 and 130,000 Å. Furthermore, an extension of the model ($1.10^{-7} < \tau_0 < 2.10^{-2}$) is deduced which reasonably well represents the observations of the ultraviolet solar flux (λλ 900 to 1700 Å). (auth)

17284 THE FAR ULTRAVIOLET SPECTRUM OF THE SUN. Gingerich, Owen (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Rich, John C. Solar Phys., 3: 82-8(Jan. 1968).

Predictions of solar flux and limb darkening calculated from the Utrecht Reference Model, the Mutschlecner model, and the Bilderberg Continuum Atmosphere are compared with the rocket ultraviolet observations. The calculations employ recent experimental and theoretical determinations of metallic photo-ionization cross sections. The spectral region between the continuous absorption edge from the first excited level of silicon at 1680 Å and the ground-state absorption edge at 1525 Å proves particularly significant for an investigation of the solar temperature minimum. The analysis indicates that the solar temperature minimum is relatively broad and flat, having a nearly constant temperature over somewhat more than a scale height, and that the chromospheric rise occurs just above $\tau_{5000} = 10^{-4}$ or so. Within the assumptions of the present models, a satisfactory interpretation of the ultraviolet spectrum can be reached with a temperature minimum of 4600 ± 100°K. (auth)

17285 LIMB-DARKENING OBSERVATIONS BETWEEN 1800 AND 2900 A. Bonnet, R. M.; Blamont, J. E. (CNRS, Verrieres-le-Buisson, France). Solar Phys., 3: 64-81(Jan. 1968).

Several attempts were made at measuring the solar limb darkening in the continuous spectrum between 1800 and 2900 Å. Good spectroheliograms were obtained during a rocket flight in November 1964 and during a balloon flight in October 1966 at 2190 Å, 2665 Å, 2885 Å, and 1980 Å, 2235 Å respectively. A rocket flown at the beginning of 1967 provided excellent spectra allowing the measurement of center-to-limb variation in the continuum and lines from 1800 to 2800 Å. The first series of pictures yielded absolute values of the central intensity leading to a minimum temperature close to 4700°K. The continuous opacity of the photosphere layers was deduced from the two first experiments. It seems that a non-metallic source of continuous absorption must be taken into account between 2500 and 3000 Å. Moreover, as the source functions for the shortest wavelengths show a very flat variation near the minimum temperature, it seems that the transition zone between the photosphere and the chromosphere must be very gradual. These results are discussed in the light of the latest results deduced from the new spectra obtained. (auth)

17286 EFFECTS OF LINE BLANKETING ON THE SOLAR WINDOWS. Carbon, Duane; Gingerich, Owen; Kurucz, Robert (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll., Cambridge, Mass.). Solar Phys., 3: 55-63 (Jan. 1968).

The increasingly high flux predicted to the violet of 4500 Å by many model solar atmospheres stands in contradiction to the observations. Since one possible cause of the disagreement is that the solar 'windows' by which the observed continuum is established might be obscured by line wings, detailed calculations of these narrow spectral regions were made. With the exception of a few windows affected by the wings of Balmer lines, those redward of the Balmer discontinuity appear free of line blanketing. Even the assumption that the ultraviolet continuum is depressed 5% by unseen lines not included in the calculations leaves substantial disagreements between the models and observations. The discrepancies could perhaps be explained by a veil of weak lines across the ultraviolet spectrum. Calculations indicate that the windows become narrower at shorter wavelengths. Many of the ambiguities to the violet of 3600 Å would be resolved if spectrophotometric tracings with a band pass of 10 mÅ were available. (auth)

17287 THE HIGH-DISPERSION CONTINUOUS ULTRAVIOLET SOLAR SPECTRUM AND THE BALMER-JUMP. Houtgast, J. (Univ., Utrecht). Solar Phys., 3: 47-54(Jan. 1968).

Among the intensities, determined at about 200 wavelengths between λ 3000 and λ 4100 Å in the spectrum of the center of the Sun's disk (HOUTGAST, 1965), the 32 highest ones (windows) were plotted and compared with absolute intensities given by other authors. The intensities in between the Fraunhofer lines from λ 3600 to λ 4000 Å, as determined here for the first time with high dispersion, reveal a detailed picture of several absorption features, one of which can be attributed to a Balmer jump of 0.03, a value in accordance with that found for stars and in agreement with the strengths of the high Balmer lines. The much higher value of the Balmer jump for the Sun, as quoted in literature, in reality refers to the total intensity jump between λ 4000 and λ 3600 Å, which is mainly due to the crowding of Fraunhofer lines. (auth)

17288 OBSERVATIONAL STUDIES OF THE SOLAR INTENSITY PROFILE IN THE FAR INFRARED AND MILLIMETER REGIONS. Noyes, R. W. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Beckers, J. M.; Low, F. J. Solar Phys., 3: 36-46(Jan. 1968).

Observations of the intensity distribution near the solar limb at 2.43 and 22.5 μ show the absence of limb brightening to within 1 or 2 arc sec of the limb. Observations at 1.2 mm indicate limb brightening at this wavelength. These results are compared with the Utrecht Reference Photosphere and with existing data on the solar flux in the millimeter range, and suggest that the temperature minimum is broad and extends above $\tau_{5000} = 2 \times 10^{-3}$. A sharp rise of temperature is required above $\tau_{5000} = 10^{-5}$. (auth)

17289 OBSERVATIONS OF THE CENTER-TO-LIMB VARIATION OF THE SOLAR BRIGHTNESS IN THE FAR INFRARED (10 TO 25 MICRONS). Lena, Pierre J. (Univ., Paris). Solar Phys., 3: 28-35(Jan. 1968).

Existing models of the solar atmosphere predict a limb brightening in the far infrared wavelengths. At shorter wavelengths this effect is confined to the extreme limb but at 25 μ it extends inward from the limb to cos θ = 0.3. Observations of $I(\mu)/I(1.0)$ were made with the McMath Solar Telescope through atmospheric windows at 10.4, 17.9, 20.4, and 24.2 microns, respectively. The measurements, after having been smoothed, are compared with the theoretical predictions taking into account the diffraction pattern of the telescope. The expected brightening does not appear. (auth)

17290 SPECTRUM MEASUREMENTS OF THE SUN NEAR 1 CM WAVELENGTH. Staelin, David H.; Gaut, Norman E.; Law, Sara E.; Sullivan III, Woodruff T. (Massachusetts Inst. of Tech., Cambridge). Solar Phys., 3: 26-7(Jan. 1968).

The solar brightness temperature was measured at frequencies of 19.0, 21.0, 22.2, 23.5, and 25.5 GHz on 8 days in February and March, 1966. The observed average brightness temperatures were 10,800, 10,900, 11,000, 10,700, and 9,800°K, respectively. The daily values were close to these averages. (auth)

17291 STELLAR ROTATIONS OBSERVED WITH A SPECTRACON. McGee, J. D.; Khogali, A.; Baum, W. A.; Kraft, R. P. Mon. Notic. Roy. Astron. Soc., 137: 303-10(1967).

The rotational velocities of some stars in the Praesepe cluster were compared with those of stars in the Hyades cluster by means of spectrograms obtained with a spectracon installed in the coudé spectrograph of the 100-inch telescope on Mount Wilson. The spectracon is an electronographic image tube developed at Imperial College. It has a photo-emissive cathode at the input end and an electron-permeable Lenard window at the output end. A description of the equipment and its performance is given. A comparison is shown with similar spectra obtained by unaided photography in the coudé spectrograph at Palomar. (auth) (UK)

17292 EXACT SOLUTIONS FOR OSCILLATING SPHERES IN GENERAL RELATIVITY. Bonnor, W. B.; Faulkes, M. C. Mon. Notic. Roy. Astron. Soc., 137: 239-51(1967).

A class of exact interior solutions is given for adiabatic spherically symmetric motion of a perfect fluid of uniform density but nonuniform pressure. This is matched to the Schwarzschild exterior solution at a moving boundary. The solutions include cases of oscillating motion in which both the pressure and the density are always positive, and the metric nonsingular. Such cases are possible models for quasar oscillations, provided it is permissible to ignore radiation flux; the period is calculated in an example The Schwarzschild static interior solution is shown to be stable to perturbations in which the density remains uniform, provided the ratio mass/radius is not too great. (auth) (UK)

17293 ROLE OF ELECTRIC FIELDS FOR THE ACCELERATION OF ENERGETIC PARTICLES IN SOLAR FLARES. Sakurai, Kunitomo (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 20: 515-27(1966).

An investigation of the generation of electric fields and of the efficiency of acceleration of high-energy particles in the solar corona is described. The electric fields due to electron-plasma and ion-acoustic waves associated with the variation of sunspot magnetic fields are thought to be a main cause of the acceleration of electrons during the explosive phase of solar flares. (IAA)

17294 COUNTS OF RADIO SOURCES AT 2700 MHz. Shimmins, A. J. (CSIRO, Sydney); Bolton, J. G.; Wall, J. V. Nature (London), 217: 818-20(Mar. 2, 1968).

Counts of radio sources from a 2,700 MHz survey made with the Parkes telescope for regions away from the galactic plane have shown a slope of −1.4 for the log N − log S relation. This is in strong contrast to the slope of −1.8 usually found in counts of radio sources at lower frequencies. This low slope at 2,700 MHz throws considerable doubt on the hypothesis that the high slope for source counts at low frequencies is associated with an evolutionary decrease of the number density or of the level of emission of the radio sources, or both. (auth) (UK)

17295 PUZZLE OF THE MISSING NEUTRINOS. Edelson, Edward New Sci., 37: 472(Feb. 29, 1968).

A hundred thousand gallons of cleaning fluid in a tank 5000 feet down at the bottom of a South Dakota gold mine has failed to detect the few neutrinos expected to arrive each day from the Sun. The discrepancy suggests that the Sun's interior may be spinning faster than was thought. (auth) (UK)

17296 CHANGES OF THE MAGNETIC FIELD STRENGTH OF SUNSPOTS DURING A GIVEN DAY. Kuenzel, H. (Astrophysikalisches Observatorium, Potsdam, Ger.). Astron. Nachr., 289: 233-40(1967). (In German).

An examination was made of photographs of 20 sunspots during May and June of 1965 to obtain magnetic field strength data. The history of other such observations is briefly treated. The average values used in the testing were derived from successive pairs of photographs, and the mean error amounted to ±169 gauss. It is mentioned that the short-term oscillations may not be treated with any amount of certainty. Field strength vacillations of 800 gauss were noted over the period of a few hours, and changes of 900 gauss were observed during the course of one day. (IAA)

17297 POLARISATION OF GALACTIC RADIO EMISSION AT λ 1.25m. Smith F. G. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London), 217: 831(Mar. 2, 1968).

Observations of synchrotron radiation from the Milky Way at λ 0.21m indicated polarisation up to 25% in a direction somewhat inclined from the perpendicular to the spiral arm. At λ 0.73m the percentage polarisation and the polarised area were less, indicating that Faraday rotation was becoming important. Polarisation at longer wavelengths has hitherto remained unknown, in spite of several attempts to measure it. The reduction of polarisation at longer wavelengths might be attributed to Faraday rotation within a region of highly organised field, generally running along the spiral arm. Some studies are described employing the Mark I 250-ft telescope as a polarimeter at λ 1.25m. Most of the region near l = 135°, b = 5° appeared to be unexpectedly highly polarised at λ 1.25m. The high degree of polarisation indicated that even for this long wavelength there was no rotation greater than about 1 radian within a substantial proportion of the line of sight. The wide angle of sky covered by the polarised regions suggests that the electron density must be less than 0.03 cm^{-3} in a considerable region of the spiral arm. (UK)

17298 SPECTRUM OF THE RADIO SOURCE 4C 50.11/NRAO 150. Hughes, V. A.; Potter, R. V. (Queen's Univ., Kingston, Ont.). Nature (London), 217: 832-3(Mar. 2, 1968).

Most extragalactic radio sources have a spectrum which, over a limited frequency range, is of the form $S\alpha\nu^{-\alpha}$, where S is flux density and ν is frequency. The spectral index α is usually constant over a considerable frequency range, which implies a straight spectrum when plotted logarithmically. For some sources, however, this index changes slowly with frequency, with the result that the spectra are concave or convex. It is believed that the radiation is produced by the synchrotron mechanism, where energy losses by the electrons can lead to an increase in slope, and where different component sources may contribute to the overall spectrum. High-frequency observations have shown that the sources 3C 84 and 3C 279 have spectra which decrease in flux density from about 38 MHz towards higher frequencies, but beyond 3,000 MHz the slope is positive. This suggested the presence of a small diameter component which had a low frequency cutoff due to synchrotron self-absorption, and stimulated a search for other sources with similar spectra. Recent observations at 3,200, 6,600, and 10,600 MHz, using the 150 ft telescope of the Algonquin Radio Observatory, have indicated that the source 4C 50.11/NRAO 150 is of this form, but with the addition of two apparent peaks at about 350 and 9,000 MHz. The spectrum is reproduced, and the observations are discussed in the present communication. It is suggested that the source is worthy of further investigation with long baseline radio interferometers. It is also still possible that the source could be observed at optical wavelengths. The suggestion is that the source may be a radio galaxy or quasar in the early stages of development. (UK)

17299 MEASUREMENTS OF SOLAR MAGNETIC FIELDS NEAR DARK FILAMENTS. von Klueber, H. Mon. Notic. Roy. Astron. Soc., 137: 297-301(1967).

A number of typical examples for the longitudinal magnetic field configuration on both sides of dark chromospheric filaments are given. They were obtained by combining an Hα monochromatic filter with the Cambridge Solar Magnetograph, now operating in Malta. (auth) (UK)

17300 IRREGULARITIES OF PLASMA DENSITY IN THE SOLAR NEIGHBORHOOD. Okoye, S. E.; Hewish, A. Mon. Notic. Roy. Astron. Soc., 137: 287-96(1967).

Observations of radio scattering in the outer corona and the interplanetary medium were carried out in 1964 using a 38-Mc interferometer on a baseline of 10 km. The radial dependence of scattering was studied over the range 10 to 100 R_0, and the gradient was found to become progressively less steep at large distances. This result explains some discrepancies between earlier measurements, and suggests that the irregularities are caused by plasma instability. The scattering at all distances has decreased by a factor of 5 since 1959. (auth) (UK)

17301 ON THE COSMOLOGY OF ALFVEN AND KLEIN. Hunter, J. H. Jr. Mon. Notic. Roy. Astron. Soc., 137: 271-4 (1967).

An approximate treatment of the Alfvén–Klein metagalaxy (Ark. Fys., 23: 187(1962)) is presented with a view to determining whether this cosmology could account for the background black-body radiation in the Universe. It is shown that no nonrotating cosmological model of this type would have been able to establish a black-body radiation field at the epoch of minimum radius and then re-expand to infinity. (auth) (UK)

17302 THE SOLAR SODIUM D-LINES. II. SCATTERING PROFILES. Finn, G. D.; Mugglestone, D.; Young, R. L. Mon. Notic. Roy. Astron. Soc., 137: 445-62(1967).

The profiles of the sodium D lines are considered under conditions of coherent and of noncoherent scattering. It is found that the line source function is collisionally controlled, and that the derived line profiles are generally in good agreement with the observed profiles of Waddell (Astrophys. J. 136: 223(1962)). Two model solar atmospheres are considered: one with, and one without, a temperature increase in the lower chromosphere. A preliminary investigation shows that excellent agreement can be obtained in a comparatively simple program of curve-fitting; the values of the scattering parameter ϵ derived in such a manner are, however, in disagreement with those derived theoretically. In a self-consistent study of the line-profiles, i.e., where the scattering parameter $\epsilon(\tau_\nu)$ and the non-LTE populations of the levels $b_L(\tau_\nu)$ are determined under the physical conditions imposed by the model atmosphere, the predicted line-profiles are in moderately good agreement with those observed. A study is made of the sensitivity of the predicted profiles to variations in the assumed microturbulent velocity ξ; it is found that the general effect of reducing ξ is to decrease the central intensity and to decrease the width of the line in the core-region. Consideration is also given to the effect, on the predicted line-profiles, of introducing the determined non-LTE populations of the lower level $b_L(\tau_\nu)$ in place of an assumed LTE population b_L = I; the general effect of the introduction of non-LTE populations is to decrease the central intensity and to increase the width of the line in the core-region. It is of interest to note that the introduction of non-LTE populations has the same effect on the line, at line-center, as does a reduction in the assumed value of the microturbulent velocity ξ. (auth) (UK)

17303 STUDIES IN RADIO SOURCE STRUCTURE. III. INVERSE COMPTON RADIATION FROM RADIO SOURCES. Rees, M. J. Mon. Notic. Roy. Astron. Soc., 137: 429-44(1967).

Various consequences of the inverse Compton effect in radio sources are considered. Scattering of synchrotron radiation by relativistic electrons gives rise to a higher frequency flux, which can then be scattered a second time, and so on. The resulting "Compton–synchrotron" spectrum is calculated for simple source models. The variable cores of quasars may emit more energy by the Compton effect than in the form of synchrotron radiation. The γ rays resulting from repeated scatterings could collide with photons within the quasar, producing relativistic electron–positron pairs which would modify the spectrum of the radiation. Compton scattering of synchrotron radiation would also be important in sources whose magnetic field is weak, and in very inhomogeneous extended sources. Compton scattering of the primeval black-body background limits the lifetime of relativistic electrons in sources and gives rise to an x-ray flux. This process is more important in sources with large red shifts. The contribution of inverse Compton emission to the observed x-ray background is considered briefly. (auth) (UK)

17304 RADIO DETERMINATIONS OF ELECTRON TEMPERATURES IN H II REGIONS. Field, C. Mon. Notic. Roy. Astron. Soc., 137: 419-28(1967).

Electron temperatures are derived for nine H II regions, in the anticenter region, from the absorption of background radiation at 38 MHz. A mean temperature of 6900°K is obtained, and this is discussed and compared with other experimental results and theoretical predictions. (auth) (UK)

17305 THE IONIZATION STRUCTURE OF PLANETARY NEBULAE. VI. THE LYMAN CONTINUUM PROBLEM. Van Blerkom, D.; Hummer, D. G. Mon. Notic. Roy. Astron. Soc., 137: 353-74(1967).

Because of the recent evidence that a planetary nebula does not completely absorb Lyman continuum radiation for a substantial part of its life, a generalized discrete-ordinate method was used to obtain accurate numerical solutions to the ionization balance problem in pure hydrogen plane-parallel model nebulae of various optical thicknesses. The effects of incomplete absorption, interior boundary conditions and non-Planckian stellar fluxes are examined. It is found that the density of neutral hydrogen in the nebula increases by less than a factor of two as the optical thickness varies from 0.5 to ∞, and is insensitive to large deviations in the stellar flux from the Planckian distribution, if the total number of Lyman photons is constant. The radius of the Strömgren sphere differs by about 5% for the two boundary conditions considered. The accuracies of two simple approximations are assessed, and conditions for their validity are obtained. (auth) (UK)

17306 HELIUM PROBLEM. Tayler, R. J. Quart. J. Roy. Astron. Soc., 8: 313-30(Dec. 1967).

At one time it appeared that all objects in the Universe, for which a helium abundance could be obtained, contained at least 25% helium by mass. This led to the suggestion that most of this was due to primeval helium production in the early stages of an expanding Universe. This view was strengthened by the detection of extragalactic microwave radiation which was apparently black body and which could have survived the very hot initial stages of the Universe, and by difficulties in understanding how so much helium could have been produced in astrophysical processes in the galactic lifetime. More recently, doubt has been cast on this simple explanation, as a number of stars have been discovered which apparently have a very low helium abundance. If the abundances are low, the helium must have been produced by processes on a smaller than universal scale, and an alternative explanation might have to be found for the microwave radiation. Modifications of the cosmological theory have been proposed which produce the microwave radiation and very little helium. However, because the original picture was so attractive, and because stellar structure calculations suggest that the helium deficient stars should have a normal helium abundance in their interiors, various suggestions have been made that the helium deficiency might be spurious. (auth) (UK)

17307 RADIAL VELOCITIES AND KINEMATICS OF GALACTIC H II REGIONS. **Miller, Joseph S. (Univ. of Wisconsin, Madison. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 151: 473-89(Feb. 1968).**

Radial velocities of thirty-six galactic H II regions are presented. Expected radial velocities have been calculated for thirty regions using distances based on published data for the stars associated with them and Schmidt's rotation curve. It is found that the rms value for the difference between the expected and observed velocities is 8.7 km/sec. For the twenty nebulae observed in the Orion and Sagittarius spiral arms, the rms difference is 6.0 km/sec, while the nine located in the Perseus arm have an rms difference of 13.1 km/sec. For five nebulae in the Perseus arm the average value of the observed minus the expected velocity is −15.4 km/sec. Observations made at 21 cm with the 300-foot dish indicate that the previously reported discrepancy between the optical and radio determinations of the position of the Perseus arm is the result of deviations in the motions of the gas in the arm from what would be expected from the rotation curves generally used in 21-cm studies. The solar motion and Oort's A determined from H II regions agree very well with those determined from Cepheids, and it is concluded that there is no significant difference between the systemic motions of these young stars and the nebulae. (auth)

17308 SPECULATIONS OF SCIENCE ABOUT THE UNIVERSE. Greenstein, Jesse L. pp 15-26 of Scientific Progress and Human Values. Hutchings, Edward; Hutchings, Elizabeth (eds.). New York, American Elsevier Publishing Co., Inc., 1967.

From Conference on Scientific Progress and Human Values, Pasadena, Calif. See CONF-661058.

The major astronomical problems change and evolve as more is learned about physics and the real world. What is known now can be divided between (a) what is "normal"—the peaceful, slow evolutionary processes which are understood moderately well; (b) what is "explosive" or "high-energy"—the still mysterious events of incredible violence and relatively short duration; and (c) what is largely unknown—such ultimate questions as those of cosmology, the beginning of things, and of the place of consciousness in the Universe. (W.D.M.)

17309 NONOCCURRENCE OF COSMOLOGICAL SINGULARITIES IN TREDER'S GRAVITATION THEORY. **Kasper, Uwe (Institut fuer Relativistische und Extragalaktische, Potsdam, Ger.). Ann. Phys. (Leipzig), 7: 265-71(1967). (In German).**

In Treder's gravitation theory the cosmological model with radiation and the cosmological model with energy—momentum tensor $T^l_k = \rho u_k u^l$ are considered. It is assumed that cosmological models have the Robertson—Walker metric and that curvature of 3-dimensional sub-spaces t = const. vanishes. These cosmological models do not have cosmological singularity. (auth)

17310 LARGE-SCALE DENSITY INHOMOGENEITIES IN THE UNIVERSE. **Rees, M. J.; Sciama, D. W. (Cambridge, Univ., Eng.). Nature (London), 217: 511-16(Feb. 10, 1968).**

The possibility of large-scale density inhomogeneities (such as quasar clusters) in the Universe is discussed; their effect on the angular distribution of the cosmic black-body radiation could potentially be observable. (auth) (UK)

17311 INFLUENCE OF RADIATION FIELDS ON THE PROCESS OF DIELECTRONIC RECOMBINATION. **Sunyaev, R. (Inst. of Applied Mathematics, Moscow); Vainshtein, L. Astrophys. Lett., 1: 69-70(Jan. 1968).**

The rate of dielectronic recombination may be reduced in the presence of a high-density radiation field. The situation in the solar corona is briefly considered. (auth)

17312 ROLE OF TWISTING IN THE EVOLUTION OF BIPOLAR SUNSPOT GROUPS. **Tuominen, I. V.; Tuominen, J. (Univ. of Helsinki). Astrophys. Lett., 1: 95-7(Jan. 1968).**

The possibility of deriving information about angular velocity distribution in the outer part of the Sun from observed behavior of sunspots is considered. The main result is given. (auth)

17313 BLACK-BODY RADIATION IN A COLD UNIVERSE. **Layzer, D. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. Lett., 1: 99-102(Jan. 1968).**

Observational evidence indicates that the explosive events responsible for the production of extragalactic radio sources and cosmic rays could have released enough energy to account for the cosmic black-body radiation field. It is argued that much of this energy was released at an epoch ($t \simeq 3 \times 10^8$ years) when it would have been thermalized by interactions with solid grains having properties similar to present-day interstellar grains, even if their cosmic abundance had been considerably smaller than its present value. If this interpretation of the black-body radiation is correct, the primordial abundance of helium could have been much less than the value required by the currently accepted interpretation, which is based on the assumption of a hot universe ($T \rightarrow \infty$ as $t \rightarrow 0$). The choice between a hot universe and a cold universe ($T \rightarrow 0$ as $t \rightarrow 0$) also has an important bearing on the problem of galaxy formation. (auth)

17314 SHORT PERIOD VARIABILITY OF B, A, AND F STARS. I. A COMA CLUSTER DELTA-SCUTI TYPE VARIABLE. **Breger, M. (Univ. of California, Berkeley); Sanwal, N. B. Astrophys. Lett., 1: 103-4(Jan. 1968).**

From photoelectric observations HR 4684 is found to be a δ Scuti-type variable with a period of 80 minutes (0.055 d ± 0.003 d) and amplitude of 0.02 mag in visual light. This star is interesting because it is a member of the Coma cluster, has the earliest color among known δ Scuti-type variables, and has not evolved far from the main sequence. (auth)

17315 LONG-BASELINE INTERFEROMETRY OF S-BURSTS FROM JUPITER. **Brown, G. W. (Univ. of Florida, Gainesville); Carr, T. D.; Block, W. F. Astrophys. Lett., 1: 89-94(Jan. 1968).**

Interferometric observations of millisecond and hundredth-second bursts from Jupiter were made at 18 Mc during the 1966–1967 apparition, using a tape recorder interferometer with a baseline of 218 km. The indicated source size of about 6 seconds of arc is significantly smaller than that obtained by Slee and Higgins from observations of much longer bursts. An apparent arrival time delay of about a millisecond at the south end of the baseline has not yet been explained. (auth)

17316 THE $^{12}C/^{13}C$ RATIO IN THE SOLAR PHOTOSPHERE. **Lambert, D. L. (California Inst. of Tech., Pasadena); Mallia, E. A. Astrophys. Lett., 1: 85-7(Jan. 1968).**

A search for ^{13}CH lines from the CH $A^2\Delta^2 - X^2\Pi$ suggested one possible identification with a weak but relatively unblended Fraunhofer line. This line, $R_{1,2dc}(13)$, which was discussed recently by Richter and Tonner (1967), was observed with the Oxford spectrometer. The equivalent width of 1.6 ± 0.2 mÅ represents a $^{12}C/^{13}C$ ratio of 150 ± 30, which exceeds the terrestrial ratio ($^{12}C/^{13}C = 89$) by nearly a factor of two. Furthermore, a control survey suggests that the present measurement should be regarded as providing an upper limit to the ^{13}C abundance. These results support the suggestion that the terrestrial ^{13}C is the product of spallation processes in the condensing nebula surrounding the Sun. (auth)

17317 RELATIVE ABUNDANCES OF O, Mg, Cr, Mn, Fe, AND Ni IN THE SOLAR CHROMOSPHERE. **Athay, R. G. (High Altitude Observatory, Boulder, Colo.). Astrophys. Lett., 1: 71-3 (Jan. 1968).**

Relative abundances derived for the elements O, Mg, Cr, Mn, Fe, and Ni at a height of 1070 km above the solar limb are in good agreement with photospheric abundances, with the exception of Cr whose photospheric abundance is quite uncertain. No evidence is found for an anomalously high abundance of Fe nor a low abundance of O as found by Pottasch (1967) for the chromosphere–corona transition region. (auth)

17318 BRIGHTNESS TEMPERATURE OF INTERSTELLAR CLOUDS. **Rohlfs, K. (Commonwealth Scientific and Industrial Research Organization, Sydney). Astrophys. Lett., 1: 65-8(Jan. 1968).**

Two diagrams are given connecting the central line intensity of the 21-cm emission line of neutral hydrogen with the kinetic temperature, the surface density of the hydrogen of the cloud, and its equivalent turbulent temperature. It is shown that for most cases the influence of the internal cloud turbulence can be neglected. There exists a maximum surface density for the hydrogen which can be explained quantitatively by gravitational instability of larger clouds assisted by the pressure of an intercloud medium. (auth)

17319 PHYSICAL LIMITATIONS ON THE TOPOLOGY OF THE UNIVERSE. **Zel'dovich, Ya. B.; Novikov, I. D. (Inst. of Applied Mathematics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 236-7(Oct. 1, 1967).**

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 772-3(Oct. 1, 1967).

It is pointed out that recent discoveries of elementary particles, which make possible absolute definitions of "right" and "left," show that a real physical three-dimensional space cannot be nonorientable. (M.O.W.)

17320 SOLAR WIND. Beard, D. B. (Imperial Coll. of Sciences and Tech., London). Rep. Progr. Phys., 30: 409-44 (1967).

The historical evidence that the Sun is a constant source of an outward-flowing supersonic stream of ionized hydrogen and helium now called the solar wind has been confirmed by many recent satellite measurements. Although the intensity of the wind varies and increases greatly as a result of sunspot activity on the solar surface, normally during quiet times of comparative inactivity on the Sun the wind is steady. Satellites have measured the quiet steady flow as 3 protons/cm^3 for the particle density and 300 km sec^{-1} for the stream velocity. The origin of the solar wind is the thermal expansion of the solar corona against the gravitational attraction of the Sun, but at the present time it is not entirely clear whether the solar atmosphere expands hydrodynamically or simply by evaporation from the surface of the Sun. The impact of this supersonic wind of completely ionized plasma on the geomagnetic field is shown to result in a distortion and compression of the field. The Earth's magnetic dipole field is contained inside a raindrop-shaped bubble called the magnetosphere, which acts as an obstruction to the solar wind. Any large obstruction to this supersonic wind creates a bow shock on the surface, observed both by satellites near the Earth and as a source of spectacular ionized rays from the heads of large comets. The variation in the intensity of the solar wind is shown to result in changes in the observed geomagnetic field, aurora, and cosmic-ray flux. (auth) (UK)

17321 REPORTS ON THE PROGRESS OF ASTRONOMY: SOLAR ACTIVITY, PROMINENCES. Bappu, Mik. Vainu. Quart. J. Roy. Astron. Soc., 8: 273-4(Sept. 1967).

A table giving the mean daily areas and numbers of calcium prominences at the limb, derived from spectroheliograms obtained at Kodaikanal during 1966, is presented. These data are compared with the previous year's figures. (UK)

17322 REPORTS ON THE PROGRESS OF ASTRONOMY: SOLAR ACTIVITY, SUNSPOTS. Laurie, P. S. Quart. J. Roy. Astron. Soc., 8: 272-3(Sept. 1967).

A report is presented on the considerable increase in solar activity during 1966, following an unusually long quiescent period. Data are given on sunspots and solar flares. (UK)

17323 ORIGIN OF THE SOLAR SYSTEM. Alfven, H. Quart. J. Roy. Astron. Soc., 8: 215-26(Sept. 1967).

A general background to the problem of the origin of the solar system is presented, confined to indicating the general types of processes. (UK)

17324 JUPITER'S DECAMETRIC RADIO EMISSION AND THE RADIATION BELTS OF ITS GALILEAN SATELLITES. Burns, J. A. (Goddard Space Flight Center, Greenbelt, Md.). Science, 159: 971-2(Mar. 1, 1968).

Many of the observed properties of Jupiter's decametric radiation may be explained by the postulation that the inner Galilean satellites of Jupiter have magnetic properties that strongly distort Jupiter's magnetic field in the region of each satellite. Charged particles from Jupiter's radiation belts are trapped by these distorted fields and emit synchrotron radiation. (auth)

17325 AN APPROXIMATE CALCULATION OF RADIATIVE HEATING AND RADIATION EQUILIBRIUM IN THE MARTIAN ATMOSPHERE. Gierasch, Peter; Goody, Richard (Harvard Univ., Cambridge, Mass.). Planet. Space Sci., 15: 1465-77(Oct. 1967).

A simple approximation to the equation of radiative heating was developed for use in dynamical calculations of the Martian atmosphere. The integral equation is reduced to a linear algebraic equation by means of a trapezoidal approximation which pays particular attention to radiation exchange with the planet's surface and with space. The accuracy of the approximation is demonstrated both for radiative equilibrium and for perturbation heating calculations in a pure carbon dioxide atmosphere. (auth) (UK)

17326 KINETIC THEORY OF A SELF-GRAVITATING STELLAR SYSTEM WITH UNIFORM ROTATION. Wu, C.-S. (Massachusetts Inst. of Tech., Cambridge. Univ. of Maryland, College Park). Phys. Fluids, 11: 316-25(Feb. 1968).

A kinetic equation for a homogeneous and uniformly rotating stellar system is established, based on statistical theory. The theory includes both the effects of direct gravitational encounters and collective processes. The expressions for the dynamic friction and diffusion tensor are provided. Based on these results, characteristic relaxation times may be discussed readily. (auth)

17327 CORE OF THE GALAXY NGC 5548. Bardin, Claude; Chopinet, Marguerite; Duflot-Augarde, Renee (Observatoire de Marseille). Compt. Rend., Ser. A and B, 265: 1149-50(Nov. 13, 1967). (In French).

Spectrophotometric studies of the core of NGC 5548 seemed to show that its electron temperature varies with time. (tr-auth)

17328 CONTRIBUTION OF GRAVITATION TO THE REDDENING OF THE LIGHT EMITTED BY GALAXIES. Proisy, Paul (Observatoire de Lyon). Compt. Rend., Ser. A and B, 265: 1145-8(Nov. 13, 1967). (In French).

Gravitation produces a reddening $d\lambda/\lambda = h_g$ of light proportional to the length of the trajectory traveled, which depends only on the total mass M and the dimensions of the universe (radius of curvature R and density ρ). The expression for the reddening was determined. According to the values used for M and R or ρ, h_g varies from 3 to 100% of the reddening observed. (tr-auth)

17329 COSMOGONY OF THE SOLAR SYSTEM AND ORIGIN OF THE DEUTERIUM. Schatzman, E. (Institut d'Astrophysique, Paris). Ann. Astrophys., 30: 963-73(Nov.-Dec. 1967).

A model of the nebular theory of Laplace is developed. The nebular disc is lost from the equator during contraction of the rotating protosun. The mass distribution is compatible with the distribution of the planets in the solar system. The contracting protosun is stabilized by turbulence and does not collapse. The effect of the solar cosmic rays is investigated. It determines the structure of the disc and its evolution. The depletion of hydrogen takes place in less than 10^6 years, and the production of deuterium by spallation of helium is sufficient to explain the present ratio of deuterium to hydrogen in the solar system. (auth)

17330 SECULAR STABILITY OF MODELS WITH ISOTHERMAL CORES. Gabriel, M.; Ledoux, P. (Univ., Liege). Ann. Astrophys., 30: 975-83(Nov.-Dec. 1967). (In French).

The secular stability of models with isothermal cores is discussed and it is shown that the critical model of Schönberg–Chandrasekhar, which divides the stable from the unstable models, is neutral with respect to a linear modification consisting of a contraction of the central regions and an expansion of the envelope (or vice-versa). In Henyey's method, secular instability should correspond to the vanishing of a determinant. This may correspond to a bifurcation point, and implications are briefly discussed. (auth)

17331 INSTABILITY OF GRAVITY WAVES. Souffrin, P.; Spiegel, E. A. (Institut d'Astrophysique, Paris). Ann. Astrophys., 30: 985-93(Nov.-Dec. 1967).

The influence of thermal dissipation on the stability of gravity waves in a medium containing a convective zone was studied. First, a discussion of the physical process which gives rise to overstability (vibrational instability) of gravity waves is presented. The study of a plane parallel model constituted of a zone with subadiabatic temperature gradient above a zone with superadiabatic gradient confirms this discussion and leads to some instability criteria. Finally, the possible role of this instability in stars is considered. (auth)

17332 MAGNETIC VARIABILITY OF STARS BY PRECESSION. Brosche, P. (Astronomisches Reche-Institut, Heidelberg). Ann. Astrophys., 30: 995-8(Nov.-Dec. 1967). (In French).

The periodic field strength variations of magnetic stars are interpreted as precession caused by a companion. This mechanism gives the same field variations as the oblique rotator. However, it permits the rotational and the magnetic axis to coincide. A characteristic period of 10^d could be explained by a companion of 0.01 $M_\odot$ in an orbit of radius 0.01 AU. (auth)

17333 CONTRIBUTION TO A STUDY OF THE ATMOSPHERES OF COLD DWARF STARS. II. CHROMOSPHERES OF COLD DWARF STARS. Kandel, Robert (Observatoire de Paris). Ann. Astrophys., 30: 999-1021(Nov.-Dec. 1967). (In French).

Having defined "stellar chromospheres," the major problems of stellar chromospheres are reviewed. Highly simplified chromosphere models are constructed; they are made of plane parallel layers, and although a "microturbulence" parameter is introduced, the structure is computed according to hydrostatic equilibrium. The Saha equation is used, which supposes that local thermodynamic equilibrium (LTE) holds, to calculate ionization. Having more or less arbitrarily fixed the other parameters, the properties of these models are studied, varying only two parameters: the the mass and the temperature of the chromospheres. For each of the models the profiles of the H and K lines of Ca II were computed, taking partially into account departures from LTE. Comparison of the computed profiles with the observed emission peaks enables one to define a relation between the mass and temperature of models which are to represent the observations. The net radiative energy loss of the models is evaluated for the ions Ca^+, H^-, Mg^+, and for atomic hydrogen, taking non-LTE effects into account. This enables one to define and exclude the regions of instability in the model mass–temperature plane. Moreover, the calculation for hydrogen leads one to eliminate models which are too hot and dense, for which the H_α line would be in emission, contrary to observation. For the region in the mass-temperature plane which remains compatible with the observations, it is found that the net radiative energy loss is dominated by the H and K lines of Mg II at 2800 Å, which radiate about 10 times the energy in the Ca II H and K emission peaks. A very rough evaluation of the mechanical energy available for heating the chromosphere is made and compared with the total radiative energy loss evaluated above. Finally the implications of these results with regard to various hypotheses formulated on the evolution of stellar chromospheres are discussed. (auth)

17334 INFLUENCE OF THE INVERSE COMPTON EFFECT ON THE ENERGY AND RELATIVISTIC ELECTRON LIFETIME IN NONTHERMAL RADIO SOURCES. Pfleiderer, Joerg (Astronomische Institute, Bonn). Ann. Astrophys., 30: 1023-37(Nov.-Dec. 1967). (In German).

The inverse Compton effect amplifies the energies of photons by collisions with relativistic electrons. The mean energy of the electrons is limited by a back-feed mechanism which is produced by the possibility of multiple scattering of a photon by the electrons. A back-feed factor $Q = 4R\sigma_0 N_e \gamma^{*2}/3$ is defined, with R radius of the object, σ_0 Thomson cross section, N_e density of relativistic electrons, and γ^* their square root mean energy in units of rest mass energy $m_0 c^2$. $Q > 1$ refers to unsteady conditions unless nearly all radiation is due to inverse Compton effect and the spectrum of the radiation is flat (spectral index < 1) up to the γ-ray region where photons have energies equal to the mean electron energy. For $\frac{1}{2} < Q < 1$, the Compton radiation dominates, energetically, over the synchrotron radiation and any thermal radiation. In this range of Q, magnetohydrostatic equilibrium demands that the lifetimes of the relativistic electrons are smaller than R/c, and the electrons are, necessarily, produced in situ. If the electrons are secondary products of relativistic protons, the mean proton lifetime is smaller than R/c, too. A true acceleration mechanism must exist in situ, i.e. at any place within the object where nonthermal radiation is emitted. An estimate of Q gives small values, i.e. negligible Compton radiation compared to the total radiation, for supernova remnants (Crab nebula), galaxies, radio galaxies, and the intergalactic space. For quasars, one has $Q > 1$ unless either the hypothesis of local origin is correct or the lifetimes of the relativistic electrons are extremely small, of the order of minutes to hours. Under the assumption that most of the nonthermal radiation is magnetobremsstrahlung, maximum values for the density, mean energy, and lifetimes of relativistic electrons, and minimum values for the magnetic field and for the ratio of magnetic to cosmic-ray–electron pressure are given for different kinds of nonthermal radio sources. The magnetic field must be higher in quasars than in other radio sources: 10^{-1} gauss for the local, 10^2 gauss for the cosmological hypothesis. Synchrotron models of quasars are discussed in terms of the lifetimes of relativistic particles. In all models, a permanent production of particles is necessary. If the electrons are produced in the center only, quasars must be of local origin. In this case, the radius of quasars seems to be determined by the electron lifetimes. If the electrons are secondary products of high-energy protons, then the central production of these protons is compatible with all models. The radius of quasars might be determined, in this case, by the mean proton lifetime. It is not necessary for these conclusions to assume magnetohydrostatic equilibrium. As yet, it is not possible to decide whether or not the Compton radiation plays a major role in quasars. A further conclusion is that the long-wavelength radio radiation is emitted from a greater volume with smaller magnetic field than the microwaves and the optical continuum. (auth)

17335 A CONTRIBUTION TO THE THEORY ON THE FORMATION OF COSMIC GRAINS. Cernuschi, F.; Marsicano, F.; Codina, S. (Univ., Buenos Aires. Univ., Uruguay). Ann. Astrophys., 30: 1039-51(Nov.-Dec. 1967).

Critical comments are made regarding some of the existing theories on the formation of cosmic grains. A theory is developed in order to explain the formation of carbon grains as well as oxygen compounds as a consequence of the variation of temperature in the adiabatic expansion of gases due to a supernova explosion. With the same mechanism it is also explained the probable ice coating of the carbon cosmic grains. Considering the relative abundance of the elements which is generally accepted, it is concluded according to this theory, that the quantity of molecules of water, although considerably less than what is admitted, is enough to provide an ice mantle around the grains of carbon, whose maximum average thickness would be slightly less than the value currently adopted. (auth)

17336 DETERMINATION OF THE BACKGROUND CONTINUUM OF TWO METALLIC-LINE STARS 63 TAU AND 15 UMa. Veer-Menneret, C. Van't (Institut d'Astrophysique, Paris). Ann. Astrophys., 30: 1053-8(Nov.-Dec. 1967). (In French).

Knowledge of the physical and chemical conditions in metallic-line star atmospheres can be improved by a detailed analysis of the energy distribution in the continuum. The parameters Φ_b and D, continuum flux gradient and Balmer discontinuity, are excellent temperature criteria as far as they correctly represent the real continuum of the star. However, their value is strongly dependent upon the resolution obtained in the observations. Ten Å/mm spectra were obtained and the corrections to be introduced in low-resolution observations of the continuum of 63 Tau and 15 UMa were studied. Sliding means were computed to deduce the low-resolution spectra from the high-resolution ones. The new relative gradients obtained from comparison with a hot star are weakened by more than 20% and the $1/\lambda$ law resumed. With the new values of Φ and D, in the continuum, the two stars are found to have effective temperatures in the range 7800 to 8400°K in Mihalas' grid models. (auth)

17337 APPLICATION OF PHOTOGRAPHIC AND PHOTOELECTRIC INTERFEROMETRY TO A STUDY OF H II REGIONS. Cruvellier, P. (Observatoire, Marseille). Ann. Astrophys., 30: 1059-1111(Nov.-Dec. 1967). (In French).

The first part of this study is devoted to the detection of the faint H II regions through interference photography. After a detailed study of the best efficiency of the interference filters, a list of new H II regions found in the central spots in the Magellanic clouds is given. The second part is devoted to study of the galactic structure, by the measurement of the radial velocity of the H II regions. These results are compared to those obtained by radio astronomy on one hand and interstellar lines on the other. In particular, it has been possible to measure the radial velocity of a great number of H II regions in the southern Milky Way. It has been possible to detect an obvious divergence to the circular rotation law through a more thorough study of the regions situated in the direction of the galactic center. The third part is devoted to interferential spectrophotometry. It was absolutely necessary to perfect a very precise method in the measurement of emission lines profiles as well as in the intensity ratios in some particular lines—particularly in the doublet 3727/29 of [O II]. The last part is devoted to the measurement of the variation of the intensity ratio of the two lines 3727/29 of [O II] in the great Orion nebula. The preciseness of the measurement allows to show off an elliptical repartition of the electronic density around the trapezium. (auth)

17338 SHOCK WAVE PROPAGATION IN DEGENERATE GASES. Baglin, Annie (Institut d'Astrophysique, Paris). Ann. Astrophys., 30: 1113-17(Nov.-Dec. 1967).

The problem of the propagation of a shock wave in a degenerate electron gas has been studied only in the case of nonrelativistic degeneracy, when pressure and densities can be expressed in terms of the degeneracy parameter by the well known $F_{1/2}(\eta)$ and $F_{3/2}(\eta)$ functions. In this paper the case of a highly degenerate and relativistic gas is considered. These physical conditions occur in stars of high density like white dwarfs and particularly in those models achieving a dynamical instability and collapsing. Temperature variations for a given shock strength rise very rapidly when the degeneracy parameter increases. (auth)

17339 DETECTION OF GRAVITATIONAL WAVES BY STELLAR SCINTILLATION IN SPACE. Winterberg, F. (Univ. of Nevada, Reno). Nuovo Cim. (10), 53B: 264-79(Feb. 11, 1968).

It is shown that gravitational waves generated by close binaries in our galaxy will lead to stellar scintillation. This scintillation seems to be large enough to be detectable with sensitive photocounters in space. With two observation stations separated by a sufficiently large distance in space, it should be also possible to measure the space-time correlation of the predicted scintillation effect and, hence, the propagation velocity of gravitational waves. It is believed that quasars, depending on their state of gravitational collapse, can emit a large amount of gravitational radiation. Under certain assumptions, one can show that the gravitational waves emitted by quasars may result in large brightness scintillation of far-distant quasars. The observations of quasars seem to support the theoretically predicted brightness fluctuations and characteristic fluctuation times. Finally, the question of gravitational background radiation in the universe is considered in connection with the recently discovered 4°K electromagnetic black-body radiation. (auth)

17340 SOLAR WIND ION COMPOSITION. Bame, S. J.; Hundhausen, A. J.; Asbridge, J. R.; Strong, I. B. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett., 20: 393-5(Feb. 19, 1968). (LA-DC-9235).

In addition to the two species previously observed in the solar wind, H^+ and $^4He^{++}$, Vela satellite measurements reveal the presence of ions of $^3He^{++}$, $^4He^+$, various ion species of ^{16}O, and other unidentified heavy ions. From the number ratios of the O^{+7}, O^{+6}, and O^{+5} ion species measured near earth, it may be inferred that the ionization state ratios are established deep within the solar corona at million-degree temperatures. (auth)

17341 ORIGIN OF SOLAR FLARE MICROWAVE RADIO BURSTS. Lingenfelter, R. E.; Ramaty, R. (Univ. of California, Los Angeles). Planet. Space Sci., 15: 1301-11(Aug. 1967).

The broadband microwave radio bursts associated with solar flares are suggested to be synchrotron emission from relativistic positrons resulting from the decay of pions produced by the interaction of accelerated flare protons with the solar material. A detailed calculation is made of the positron yield and the resulting synchrotron spectrum, and good agreement is found between the calculated radioemission and the observed microwave flux density. It is suggested, therefore, that broadband microwave bursts are an indication of the presence of high density protons at the Sun even when such protons are not observable at the Earth. (auth) (UK)

17342 MICROWAVE RADIATION OF SINGLY CHARGED ^3He FROM H II REGIONS. Goldwire, Henry Crawford Jr. Houston, Tex., Rice Univ., 1967. 169p.

Thesis.

The hyperfine structure of the ground state of singly charged ^3He is considered in detail. The frequency of a photon emitted in a hyperfine transition from the singlet state to the triplet state is calculated to be 8,665,649,900 ± 1900 Hz, a value which compares favorably with an observed value. The corresponding Einstein coefficient is determined to be 1.950×10^{-12} sec^{-1}, indicating that the lifetime of the upper hyperfine state against spontaneous emission of 3.46-cm radiation is about 16,000 years. The possible abundance of ^3He in the interstellar medium is discussed and some of the important questions that may hinge upon this abundance are delineated. It is argued that in H II regions, ^3He will exist primarily as ^3He II in the ground state. From considerations of the electron collisional cross section for deexcitation of the singlet hyperfine component of the ^3He II ground state, the spin temperature of ^3He II in H II regions is shown to be equal to the kinetic temperature. For an assumed $^3He/H$ interstellar abundance ratio of 4×10^{-5}, the expected intensity of the ground state hyperfine transition radiation received from certain H II regions is found to be near the limits of detectability by present techniques. It is shown that the microwave method can lead to the setting of an upper limit of $\sim 10^{-4}$ to 10^{-6} for the ^3He to H abundance; this is contrasted with the present $\sim 10^{-2}$ upper limit established by optical means. High quantum level transitions of hydrogen and helium near 3.46 cm are shown not to interfere with observations of the ^3He II microwave line. The electron spin-exchange cross section is derived for electron scattering from ions and is related to the hyperfine conversion cross sections. The scattering phase shifts are computed by the quantum defect method. The singlet state deexcitation cross section is calculated as a function of the incident electron energy. This cross section is also determined for a thermal distribution of electron energies. In addition, the spin-exchange cross section for electrons upon neutral hydrogen is recomputed using the more accurate phase shifts now available. It is concluded that the rf observation of the 3.46-cm hyperfine line of ^3He II may offer the first direct evidence for the presence of ^3He in the interstellar medium. (Disser. Abstr.)

17343 TRANSFER OF LYMAN-α IN DIFFUSE NEBULAE. Auer, Lawrence Herman. Princeton, N. J.; Princeton Univ., 1967. 65p.

The Monte Carlo method is applied to the solution of the equation of transfer for Lyman-α radiation in nebulae with optical thicknesses up to 10^5. Plane parallel geometry, two-level atoms, and constant temperature are assumed. The correlation between the direction of scattering and the frequency redistribution is taken into account exactly. A method is developed for accelerating the solution by treating the line core analytically and using the Monte Carlo only in the wings. It is found that for Doppler broadening the assumption of complete redistribution is a reasonably satisfactory approximation. The mean number of scatterings before escape is on the order of τ_o. For lines with finite natural width, the presence of Lorentz wings, where scattering tends to be coherent, reduces the mean number of scatterings from the case with zero natural width. This effect is seen only after the optical depth at line center has become great enough that the nebula is opaque at all frequencies in the core. The emergent flux has a double-humped frequency distribution. When the ratio of the natural width to the Doppler width is increased, the width of the emergent line is also increased. For density-bounded H II regions with optical thickness at the line center 10^5, illuminated by an incident Lyman continuum flux, the energy density in Lyman-α does not rise to more than 25 times the energy density of the incident continuum radiation. Radiation pressure from Lyman-α does not become large enough to have dynamical effects. Two-photon emission is negligible, but if the grain density within the H II region is as high as it is in interstellar space, almost all Lyman-α photons will be absorbed before they can escape. (Disser. Abstr.)

Atomic and Molecular Physics

Refer also to abstracts 16880, 16945, 16961, 17250, 17754–17756, 17774, 17830, 17898, 18019, 18110, and 18311.

17344 (IAE-1277) PLAZMENNYE NEUSTOICHIVOSTI I KOMPENSATSIYA PROSTRANSTVENNOGO ZARYADA IONNOGO PUCHKA. (Plasma Instability and Compensation of the Ion Beam Space Charge). Nezlin, M. V. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1966. 43p. Dep.

The mechanism of strong variable electric field formation is analyzed for an ionic beam whose space charge is compensated by electrons formed by the beam in a rarefied gas. The nature of plasma instabilities responsible for dynamic beam decompensation was investigated experimentally. New methods are proposed for controlling the instabilities. The results obtained are claimed to be applicable to all physical installations utilizing intense ion beams in a strong magnetic field, e.g., electromagnetic isotope separators and plasma traps with external fast ion injection. (JPRS)

17345 (LA-3691) ATOMIC STRUCTURE CALCULATIONS. II. HARTREE-FOCK WAVEFUNCTIONS AND RADIAL EXPECTATION VALUES: HYDROGEN TO LAWRENCIUM. Mann, Joseph B. (Los Alamos Scientific Lab., N. Mex.). Jan. 1968. Contract W-7405-eng-36. 271p. Dep. CFSTI.

Hartree–Fock calculations were made of the electronic structure of the elements from hydrogen to lawrencium. Exchange terms were included without approximation. Tabulations of the electron wave functions and average r^n, with seven values of n from -3 to $+6$, are presented. (auth)

17346 LABORATORY MEASUREMENTS OF NEGATIVE ION REACTIONS OF ATMOSPHERIC INTEREST. Fehsenfeld, F. C.; Schmeltekopf, A. L.; Schiff, H. I.; Ferguson, E. E. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Planet. Space Sci., 15: 373-9(Feb. 1967).

Rate constants for the loss processes of negative oxygen ions such as occur in the D region of the ionosphere, were investigated in the laboratory. It was found that associative detachment reactions for O^- and O_2^- ions with atomic oxygen dominate the loss of these ions when the atomic oxygen concentration exceeds the ozone concentration. When the ozone concentration exceeds the atomic oxygen concentration the O^- and O_2^- ions will largely undergo charge transfer to the ozone, producing O_3^-. The O_3^- ions will rapidly react with CO_2 to form CO_3^-. The CO_3^- ions will react with atomic oxygen in regenerate the O_2^- ions, and will also react with NO to produce NO_2^- ions. O_3^- ions also react with NO to produce NO_3^- ions, which may be very stable in the atmosphere. The most important atmospheric negative ions may then be NO_2^-, NO_3^-, and CO_3^-, with O_2^- and O^- having lower concentrations, and O_3^- having a still lower concentration. A key consideration in the production of stable (long-lived) atmospheric negative ions is the ratio of ozone to atomic oxygen. A sufficient condition for large λ (ratio of negative ion density to electron density) is that this ratio exceeds unity. (auth) (UK)

17347 RELATIVE ISOTOPIC SHIFT IN THE ARC SPECTRUM OF Pu. SPECIFIC EFFECT. Tomkins, Frank; Gerstenkorn, Simon (Argonne National Lab., Ill.). Compt. Rend., Ser. A and B, 265: 1311-13(Dec. 6, 1967). (In French).

With the aid of the Hypeac interferential spectrometer the relative positions of the five isotopes 238, 239, 240, 241, and 242 of Pu were measured. A variation of more than 30% between the isotopic shifts 238–240 and 240–242 was observed and the relative isotopic shift (238–40)/(240–242) is not constant. It was concluded that for some transitions the specific effect attains values equal to at least ten times the normal mass effect. (tr-auth)

17348 CALCULATION OF ARGON I TRANSITION PROBABILITIES IN INTERMEDIATE COUPLING. Johnston, P. D. (Imperial Coll. of Science and Tech., London). Proc. Phys. Soc. (London), 92: 896-908(Dec. 1967).

Previous calculations of neutral argon transition probabilities were extended to higher energy levels. The transformation to intermediate coupling was carried out from the LS and the J_1j coupling schemes. The line strengths were put on an absolute scale using the Coulomb approximation. (auth) (UK)

17349 EXCITATION OF FORBIDDEN LINES: CALCULATIONS FOR THE $2p^3$, $2p^4$, $3p^2$ AND $3p^4$ ISOELECTRONIC SEQUENCES. Czyzak, S. J.; Krueger, T. K.; Saraph, H. E.; Shenning, J. Proc. Phys. Soc. (London), 92: 1146-7(Dec. 1967).

Using methods described by Saraph, Seaton and Shemming (Proc. Phys. Soc., 89: 27-34(1966)), collision strengths were calculated for the isoelectronic sequences $2p^3$, $2p^4$, $3p^2$ and $3p^4$. (auth) (UK)

17350 CESIUM-ION SPUTTERING OF SINGLE CRYSTAL COPPER AT 77°K. Olson, N. Thomas; Smith, Harold P. Jr. (Univ. of California, Berkeley). pp 591-618 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.

The total sputtering yield and angular distribution of the ejected atoms have been measured for 1- to 10-keV cesium ions sputtering the (100) face of single-crystal copper. The sputtering yields were low, being representative of low-index single-crystal sputtering, while the angular distribution verified the presence of ⟨110⟩ close-pack preferential ejection. An analytic function least-mean-square fit to the angular-distribution data provided a measure of the ⟨110⟩ focusing contribution to the total sputtering. The ⟨110⟩ focusing contribution decreased from 18% to 12% as the ion energy ranged from 1 to 10 keV indicating that close-pack focusing is a secondary sputtering mechanism. (auth)

17351 POSITRONIUM FORMATION BY POSITRON IMPACT ON HYDROGEN. Bransden, B. H.; Jundi, Z. (Univ. of Durham, Eng.). Proc. Phys. Soc. (London), 92: 880-8(Dec. 1967).

The cross section for positronium formation by positron impact on hydrogen is calculated in the two-state approximation, taking account of the polarization of the hydrogen and positronium atoms in each channel. It is found that the polarization forces dominate the cross section near the threshold for positronium formation, and evidence is presented for the existence of a positronium–proton virtual bound state that gives rise to a resonance in elastic e^+–H scattering just below the formation threshold. (auth) (UK)

17352 CALCULATION OF EXCHANGE SCATTERING AMPLITUDES. Green, T. A. (Sandia Lab., Albuquerque, N. Mex.). Proc. Phys. Soc. (London), 92: 1144-6(Dec. 1967).

The wave function used by Rudge (Proc. Phys. Soc., 85: 607-8 (1965)) as a basis for modifying the Ochkur approximation is generalized. The results obtained with the new function cast doubt on the validity of the arguments used by Rudge and Crothers (Proc. Phys. Soc., 87: 1003-5(1966)) in support of Rudge's modification. (auth) (UK)

17353 THE INFLUENCE OF ELASTIC COLLISIONS ON THE BROADENING OF ION LINES. Davis, J.; Roberts, D. E. (Imperial Coll. of Science and Tech., London). Proc. Phys. Soc. (London), 92: 889-95(Dec. 1967).

The authors recently showed that the inclusion of hyperbolic perturber orbits considerably modifies the electron impact width and shift of an isolated ion line in the adiabatic limit. In this paper these results are extended in order to estimate the effect of elastic collisions on the broadening parameters of several S II lines. Approximate values for the inelastic contribution to the widths of these lines are also reported, and the total calculated widths are found to be in satisfactory agreement with experimental measurements. Results show that elastic collisions constitute an important source of broadening for ion lines. (auth) (UK)

17354 RADIATIVE CAPTURE OF POSITRONS BY ELECTRONS AND THE USE OF THE BORN APPROXIMATION. Nieminen, I. Ark. Fys., 35: 1-30(1968).

The Gordon–Stobbe solution for formation of a hydrogen-like atom was investigated in the special case of positronium. It was found that the total cross section of the n:th level $\Sigma_1\Sigma_{n1}$ is proportional to $1/n^3$, when n → infinity. The limit $n^3\Sigma_1\Sigma_{n1}$ = constant is essentially reached when $n > \alpha/v$,v being the relative velocity between the incoming particles. This property was then used to determine $\Sigma_{tot} = \Sigma_{n,1}\Sigma_{n1}$ when Σ_{n1} was computed numerically for a sufficient number of energy levels. Tables of these calculations are given. The lifetime of positrons in an electron gas was investigated. It was found that the cross section for positronium formation at room temperature is about 300 times the corresponding cross section for annihilation in flight. The problem of the positronium formation was solved also in the Born approximation. The two solutions are compared in the limit v → infinity. It was found that in this limit the radial matrix elements related to dipole transitions $1 + 1 \rightarrow 1$ differ by a factor $(1 + 2)$. The corresponding factor for transitions $1 - 1 \rightarrow 1$ is (-31). This striking discrepancy was found to be due to the neglect of the phase shift $[(C\alpha/v)\log 2qr + \Delta_{1\pm1}]$ in the asymptotic hydrogen-like wave function of the continuous energy spectrum. (auth) (Sweden)

17355 ELECTRON DIFFRACTION IN GASES. SCATTERING IN DIFFUSE BEAMS. Rundgren, J. (Royal Inst. of Tech., Stockholm). Ark. Fys., 35: 31-49(1968).

The scattering arrangement in which a diffuse beam of electrons crosses a diffuse beam of molecules was analyzed. The detector measures a differential cross section pertaining to the entirety of scattering molecules in the common region of the crossed beams. This collective differential cross section was shown to be an angular mean of the molecular differential cross section, each angle receiving a weight determined by a collision-rate distribution in the scattering region, by a relative detector aperture, and if there is a rotating sector, by a relative sector transmission. The mathematical problem of extracting molecular structure parameters from a collective interference intensity curve is treated for the basic case of an atom pair. Finite beam extension weakens the amplitude and shifts the nodes of the molecular interference intensity curve. The effect on the amplitudes was found to be represented by an apparatus attenuation function in the form of a Fourier transform of the collision rate distribution. Apparatus attenuation also proves to be the main origin of the displacement of the nodes but a certain effect was induced by the relative detector aperture and the relative sector transmission. The beam width effect is shown to be generally angular dependent. An important inference was that appropriate focusing of the primary electron beam will eliminate any effect of its own width and the resulting diffraction pattern will be circularly symmetric round the axis of incidence. Estimates made of the beam width effect are based on a Gaussian density distribution in the molecular beam. In the case where a 1-mm molecular beam was observed by a detector distant 100 mm, apparatus attenuation will cause the measured vibrational mean-square amplitude, 1^2_{ij}, to appear too large by a fraction that amounts to 2% for the C—C bond in benzene, 5% for the U—F bond in UF_6, and 10% in heavy diatomic molecules. The anharmonic phase shift likewise becomes enlarged and the error is similar. But the effect on interatomic distances was insignificant. The two techniques for measuring molecular density distributions in electron diffraction units are discussed. By analysis of recent measurements it is suggested that the oven beam distribution with one adjustable parameter offers a realistic basis for sample size corrections. Finally, it is pointed out that intensity recording by means of track counting is likely to yield greater sensitivity than the photometric method. [auth) (Sweden)

17356 PERTURBATION THEORY OF THE SELF-CONSISTENT FIELD. Rajagopal, A. K. (Harvard Univ., Cambridge, Mass.). Nuovo Cim. (1), Suppl., 5: 794-806(1967).

Peng's perturbation equations and the random phase approximation are used to derive the Hartree–Fock self-consistent field equations. Many electron systems are also discussed. (M.O.W.)

17357 FACTORIZATION OF DIFFERENTIAL EQUATIONS AND O_4 SYMMETRY FOR THE HYDROGEN ATOM. Zambotti, G. (Univ., Pavia. Istituto Nazionale di Fisica Nucleare, Pavia). Nuovo Cim. (1), Suppl., 5: 954-62(1967).

Two properties of the infinitesimal operators of the symmetry algebra of a given Hamiltonian, H, are of being constants of the motion, and of providing recursion formulas for the eigenvectors of H. An approach was made to look for the largest set of independent ladder operators (that is, operators which give recursion formulas) commuting with the Hamiltonian. In this way it is shown that the α/r potential is the only central potential such that the recursion formulas for the corresponding Schrödinger equation give rise to (nontrivial) ladder operators commuting with the Hamiltonian. (M.O.W.)

17358 CHARACTER OF THE AUTOIONIZING D STATES IN HELIUM. Altick, P. L.; Moore, E. N. (Univ. of Nevada, Reno). Proc. Phys. Soc. (London), 92: 853-6(Dec. 1967).

The structure of some low-lying autoionizing D states in helium was investigated. Eigenvectors are presented which show that a plus–minus classification is appropriate. The relationship between structure and width is discussed. (auth) (UK)

17359 DIFFERENTIAL POLARIZABILITY IN THE GROUND STATE OF THE HYDROGEN ATOM. Sandars, P. G. H. (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 92: 857-61(Dec. 1967).

The differential polarizabilities in the ground states of hydrogen and the alkalis are discussed. General angular momentum arguments are used to separate the contributions from the different hyperfine-structure interactions. Three separate polarizabilities are introduced, and their contributions to the quadratic Stark effect are given. Explicit expressions for the polarizabilities are found for hydrogen. (auth) (UK)

17360 EVALUATION OF EXCHANGE MATRIX ELEMENTS FOR HEAVY PARTICLE COLLISIONS. Cheshire, I. M. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 92: 862-5(Dec. 1967).

It is shown how the one-electron exchange integral which arises in the theory of heavy-particle collisions can be expressed as the solution of a first-order differential equation with respect to time. It is expected that this method will have a wide application in the calculation of heavy particle collision phenomena at high energies. (auth) (UK)

17361 NUCLEAR SYMMETRY IN H^+ + H (1s) ELASTIC AND RESONANT EXCHANGE COLLISIONS. Smith, Francis J. (Queen's Univ. of Belfast). Proc. Phys. Soc. (London), 92: 866-70(Dec. 1967).

Total charge-transfer cross sections were calculated for H^+–H collisions, taking account of nuclear symmetry, at incident energies between 2 eV and 2 keV. It is shown that nuclear symmetry has a negligible effect on the cross sections above 3 eV. The cross sections were above the (Proc. Phys. Soc., 66: 173-7(1953)) Dalgarno–Yadav values, but still below the experimental cross sections of (Phys. Rev., 119: 663-8(1960)) Fite et al. It is suggested that this difference might be partly due to the geometry of the apparatus, and partly due to scattering near the rainbow angles associated with the gerade potential. (auth) (UK)

17362 EMPIRICAL CALCULATIONS FOR ELECTRON-IMPACT IONIZATION OF THE ALKALI METAL ATOMS. Prasad, S. S. (Queen's Univ. of Belfast). Proc. Phys. Soc. (London), 92: 871-4(Dec. 1967).

Electron-impact ionization cross sections for Li, Na, K, and Rb were computed using empirical methods. The results are in fair agreement with experiment in the moderate- to high-energy region. In the same energy region, however, the quantal calculations seriously underestimate the cross sections. (auth) (UK)

17363 CLASSICAL MODEL FOR ELECTRON AND PROTON IMPACT IONIZATION. Catlow, G. W.; McDowell, M. R. C. (Univ. of Durham, Eng.). Proc. Phys. Soc. (London), 92: 875-9 (Dec. 1967).

Ionization cross sections of He, Li, O, and N by electrons and protons are calculated in a classical model, and compared, where possible, with quantal calculations and experiment. (auth) (UK)

17364 SUPERPOSITION OF CONFIGURATION RESULTS FOR Si II. Fischer, Charlotte Froese (Univ. of British Columbia, Vancouver). Astrophys. J., 151: 759-64(Feb. 1968).

The method of superposition of configuration (SOC) was applied to a series of states in Si II. The two $3s3p^2\ {}^2D$ and $3s^23d\ {}^2D$ configurations interacted strongly and resulted in two states that were far from orthogonal. The SOC theory was extended to include an orthogonality constraint and the upper ^2D state determined orthogonal to the lower ^2D state. The gf-values for a series of transitions are reported and compared with other approximations and, in a few cases, with experiment. The SOC method gives σ^2 values which may differ considerably from the corresponding Hartree–Fock values. In most cases the agreement with experiment is thereby improved, but for $3d\ {}^2D \rightarrow 4f\ {}^2F$ it is worse. (auth)

17365 EXCITATION OF L-SHELL ELECTRONS IN Al AND Al_2O_3 BY 20-keV ELECTRONS. Swanson, N.; Powell, C. J. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 167: 592-600(Mar. 15, 1968).

The energy-loss distributions of ≈20-keV electrons transmitted through 210- to 575-Å thick specimens of Al and Al_2O_3 have been measured at zero scattering angle. Two types of Al_2O_3 were used: films of the γ phase and amorphous films prepared by anodization. Loss spectra were obtained for an energy-loss range of 0 to 160 eV, in which structure due to L-shell excitation in Al and Al_2O_3 was observed. The positions of the absorption edges and of the peaks on the high-energy-loss side of each edge agreed well with recent x-ray absorption measurements. Slightly different structure for the two forms of Al_2O_3 was found near the edge, as recently found by x-ray absorption. From the observed intensities, the values of oscillator strengths, mass-absorption coefficients, and electron-scattering cross sections have been derived for each material up to ≈85 eV beyond the absorption edge. The Al results are in good agreement with recent x-ray measurements and are consistent with the Al_2O_3 data. The similarity in the electron energy-loss and x-ray absorption measurements is consistent with the equality of the longitudinal and transverse dielectric constants $\epsilon(\omega)$ and with the expectation that in this energy-loss region $\mathrm{Im}\epsilon = -\mathrm{Im}1/\epsilon$ to a good approximation. (auth)

17366 ALIGNMENT OF BARIUM EXCITED LEVELS BY ELECTRON IMPACTS. Chenevier, M.; Vialon, R.; Pebay-Peyroula, J. C. (CNRS, Grenoble, France). Phys. Lett., 26A: 291-2(Feb. 26, 1968).

A polarization of the light emitted by an atomic beam of barium bombarded by slow electrons was observed and lifetimes of some excited levels were estimated by Hanle effect method. (auth)

17367 POSITRON ANNIHILATION IN DEFORMED NICKEL ALLOYS. Adamenko, A. A.; Dekhtyar, I. J.; Mikhalenkov, V. S. (Inst. of Physics of Metals, Kiev). Phys. Lett., 26A: 288-9 (Feb. 26, 1968).

The angular distribution of the two-photon annihilation is measured in Ni + Co and Ni + Fe alloys in deformed and annealed states. The difference between angular correlation in deformed and annealed states is considered as a result of capturing the thermalized positrons by negatively charged dislocations which is the case in deformed material. (auth)

17368 ON THE "ANOMALOUS" MAGNETIC QUENCHING OF THREE-PHOTON ANNIHILATIONS OF POSITRONS IN POWDERED MgO. Mills, A. P. (Brandeis Univ., Waltham, Mass.). Phys. Lett., 26A: 286-7(Feb. 26, 1968).

The "anomalous" magnetic quenching of 3γ annihilations of positrons in MgO powder observed by Fiorentine is explained. (auth)

17369 ORTHOGONALITY IN THE ADIABATIC-EXCHANGE ELECTRON–ATOM SCATTERING APPROXIMATION. Labahn, R. W. (Louisiana State Univ., Baton Rouge). Phys. Lett., 26A: 326-7(Feb. 26, 1968).

The effect of imposing orthogonality between the scattering state wave function and atomic wave functions is examined. It is found that imposing orthogonality has little effect on the scattering cross section so long as a proper representation of the adiabatic polarization interaction is used. (auth)

17370 ISOTOPIC SHIFT OF 4 NATURAL ISOTOPES OF CERIUM. Champeau, R. J.; Gerstenkorn, S. (CNRS, Orsay, France. CEN, Saclay, France). Phys. Lett., 26A: 334-5 (Feb. 26, 1968). (In French).

The isotope shift of three lines of Ce I was investigated using enriched samples of ^{136}Ce and ^{138}Ce. Large variations in the relative isotope shift were observed; the specific mass effect provides an explanation of these variations. (auth)

17371 ON THE FREQUENCY SHIFT IN THOMSON SCATTERING. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Indian J. Phys., 41: 631-2(Aug. 1967).

A recent paper by Prakash (Phys. Letters 24A, 492) on the effect or radiation reaction on the nonlinear scattering of electromagnetic waves by free electrons is discussed. Initial conditions of the problem are discussed in particular. (M.O.W.)

17372 PHOTOIONIZATION OF THE M SHELL OF XENON. Deslattes, Richard D. (National Bureau of Standards, Washington, D. C.). Phys. Rev. Lett., 20: 483-5(Mar. 4, 1968).

New measurements of the continuum photoionization cross sections of xenon in the region 670 to 800 eV are reported which reveal, in the region of the M_{IV} and M_V edges, extreme nonhydrogenic behavior previously observed only at longer wavelengths. (auth)

17373 EXCITATION OF N = 2 STATES IN HYDROGEN BY ELECTRON IMPACT. Damburg, R. J.; Geltman, S. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Phys. Rev. Lett., 20: 485-7(Mar. 4, 1968).

A possible source of incompleteness is pointed out in the most recent close-coupling calculations for the excitation cross sections of the n = 2 levels in hydrogen, some of the results of which disagree with experiment. A method is presented which removes this difficulty by the implicit inclusion of all important effective polarization potential terms of order α/r^4. (auth)

17374 ZERO-POINT BUBBLES IN LIQUIDS. Briscoe, C. V.; Choi, S.-I.; Stewart, A. T. (Univ. of North Carolina, Chapel Hill). Phys. Rev. Lett., 20: 493-6(Mar. 4, 1968).

Bubbles due to the zero-point motion of positronium atoms in liquid He, H_2, Ne, and Ar were observed and their sizes determined. (auth)

17375 ENERGY AND WIDTH MEASUREMENTS OF LOW-Z PIONIC X-RAY TRANSITIONS. Harris, R. J. Jr.; Shuler, W. B.; Eckhause, M.; Siegel, R. T.; Welsh, R. E. (Coll. of William and Mary, Williamsburg, Va.). Phys. Rev. Lett., 20: 505-8(Mar. 4, 1968).

New measurements were performed of the energies and natural linewidths of 2p−1s pionic x-ray transitions, as well as muonic transition energies, in ^{6}Li, ^{7}Li, ^{9}Be, ^{10}B, ^{11}B, and ^{12}C. High-resolution Si(Li) and Ge(Li) spectrometers were used, resulting in a more precise determination than those previously reported of the transition energies and natural linewidths. Comparison of the measured complex energy shifts in the pionic transitions was made with the theory of the Ericsons and good agreement found. (auth)

17376 ANALYTIC EVALUATION OF THE KRAMERS–HEISENBERG MATRIX ELEMENT FOR COHERENT SCATTERING OF PHOTONS BY ATOMIC HYDROGEN. Gavrila, Mihai (Bucharest Univ.). Rev. Roum. Phys., 12: 745-59(1967).

The Kramers−Heisenberg matrix element for the elastic scattering of photons by a hydrogen atom in the dipole approximation is evaluated analytically in closed form. The method followed consists in writing the matrix element in terms of Green's function for the Coulomb field and of using the exact expression derived for this by Hostler and Pratt. Various integrations then yield the matrix element as a combination of hypergeometric functions in three variables of Lauricella's type F_D. However, using relations between hypergeometric functions, this complicated result can finally be expressed in terms of a single hypergeometric function of the Gauss type ${}_2F_1$, with parameters and variable depending on the photon energy. (auth)

17377 DYNAMIC GROUPS FOR THE POINT ROTOR AND THE HYDROGEN ATOM. Wolf, K. B. (Tel-Aviv Univ., Israel). Nuovo Cim. (1), Suppl., 5: 1041-50(1967).

As a concrete realization of the concept of spectrum-generating algebra used in high-energy physics, the $SO_{4,1}$ algebra has been used for the hydrogen atom. The symmetry group of this system is well known to be SO_4; this is reviewed. A considerable clarification of the problem is gained when an isomorphic problem, the point rotor, is treated. The four-dimensional point rotor, a punctual mass constrained to move on the (three-dimensional) surface of a four-sphere also has SO_4 as its symmetry group. The operators of the larger spectrum-generating algebra are constructed as simple expressions of the rotor co-ordinates and momenta. A stereographic projection of the four-sphere onto a three-dimensional manifold is defined. The meaning of the symmetry and dynamic groups of the hydrogen atom, as well as compact expressions for the generators of the $SO_{4,1}$ and $SO_{4,2}$ algebras, are given. (auth)

17378 LADDER-GRAPH APPROXIMATION IN POSITRON ANNIHILATION. Arponen, Jouko; Jauho, Pekka (Technical Univ. of Helsinki). Phys. Rev., 167: 239-44(Mar. 10, 1968).

The annihilation rate of the positron in a pure Fermi gas has been calculated (a) by using a ladder-graph approximation with an exponentially screened Coulomb interaction (which is nearly the static limit of the random-phase-approximation interaction), (b) by taking into account certain graphs up to third order in the same interaction, and (c) by using a better approximation for the interaction in a ladder-graph series. The contributions from graphs other than ladders were found to be 2 to 3% up to second order and 4 to 5% to third order. The results appear to establish that a ladder sum with a quite simple interaction approximates well the two-body propagator. The modification of the interaction has only a slight effect on the rate. At low electron densities, the ladder sum diverges because of the existence of bound states, which are proved to exist at any density as poles in the two-body propagator. (auth)

17379 MULTIPLE SCATTERING OF HIGH-ENERGY ELECTRONS FROM BERYLLIUM. Mukherjee, S. (Indian Inst. of Tech., Kharagpur). Phys. Rev., 167: 323-5(Mar. 10, 1968).

The multiple-scattering distribution function for high-energy electrons scattered from a beryllium foil has been calculated, following a method discussed in an earlier paper. Calculations were done with Thomas−Fermi as well as Hartree−Fock potentials for the beryllium atom. The results obtained with the Hartree−Fock potential were found to be in better agreement with the experimental results. (auth)

17380 HIGHER-SHELL CONTRIBUTIONS AND POLARIZATION CORRELATIONS IN SINGLE-QUANTUM ANNIHILATION OF POSITRONS. Sheth, C. V.; Swamy, N. V. V. J. (Karnatak Univ., Dharwar, India). Phys. Rev., 167: 319-22(Mar. 10, 1968).

It is shown that contribution to the single-quantum annihilation cross section from the $2s_{\frac{1}{2}}$ bound electrons cannot be ignored. Calculations of the cross sections have also been made by applying the Biedenharn−Swamy symmetric model, and the region of validity of this model is estimated. Polarization correlations are studied using Dirac−Coulomb wave functions. (auth)

17381 EFFECT OF TEMPERATURE ON THE RELAXATION CROSS SECTIONS OF THE "ORIENTATION" AND "ALIGNMENT" OF ^{198}Hg ATOMS IN THE 6 $^{3}P_{1}$ STATE BY COLLISION AGAINST RARE GAS ATOMS. Faroux, Jean-Pierre; Brossel, Jean (Faculte des Sciences, Paris). Compt. Rend., Ser. A and B, 265: 1412-14(Dec. 18, 1967). (In French).

The relaxation cross sections of the orientation and alignment of ^{198}Hg atoms in the $6\,^{3}P_{1}$ state by collisions with rare gas atoms were measured in the temperature interval from 20 to 600°C. The experimental results lead to the conclusion that, for the heavier gases Ar, Kr, and Xe, the relaxation is dominated by anisotropy of the Van de Waals dispersion forces; on the contrary, for the light gases He and Ne, the anisotropic part of the short-distance repulsive potential seems predominant. (tr-auth)

17382 NUMERICAL VALUES OF THE IONIZATION CROSS SECTIONS OF THE HYDROGEN ATOM BY MULTIPHOTONIC ABSORPTION. Gontier, Yves; Trahin, Michel (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 265: 1361-4(Dec. 18, 1967). (In French).

The numerical values of the total ionization cross sections of the hydrogen atom by simultaneous absorption of several photons are given. These results, obtained in the framework of the nonrelativistic dipolar approximation, are discussed. (tr-auth)

17383 RESONANCE CHARGE INTERACTIONS WITH A SPACE-PERIODICAL MAGNETIC FIELD IN A NONPARAXIAL CASE. Kovtun, R. I. Zh. Vychisl. Mat. Mat. Fiz., 7: 1199-1202(Sept.-Oct. 1967). (In Russian).

A general case of charge motion on a weakly modulated axially symmetric magnetic field which in a cylindrical coordinate system (r,φ,z) is described by a singular (azimuthal) vector-potential conponent A_φ. $A_\varphi = \frac{1}{2}N_0 r\{1 + \epsilon I_1(\nu r)\cos \nu z\}$, where N is the strong homogeneous field parallel to OZ, $I_1(\nu r)$ is a modified Bessel function of the first order, and $\epsilon \ll 1$. It is shown that such a problem can be resolved by the Krilov−Bogolyubov method. A resonance case is discussed, in which the charge per period of rotation along the cyclotron orbit covers the distance along the OZ axis close to the modulating field spatial period $2\pi/\nu$. The latter increases with the coordinate r and, at certain conditions, the influence of modulation may prove stronger than in the next half period, which in turn would induce a slow but systematic variation in the parameters of the charge motion, in particular in ρ and d. Such variations are analyzed. (R.V.J.)

17384 POLARIZATION OF LYMAN-ALPHA RADIATION EMITTED BY H(2S) ATOMS IN WEAK ELECTRIC FIELDS. Fite, W. L.; Kauppila, W. E.; Ott, W. R. (Univ. of Pittsburgh). Phys. Rev. Lett., 20: 409-10(Feb. 26, 1968).

In preparation for repeating and extending the experiments of Stebbings, et. al. (Phys. Rev., 119: 1939(1960)), an experimental check of the quench-radiation polarization was carried out in anticipation that Lichten's zero-polarization prediction would be quickly verified. A modulated beam of ground-state hydrogen atoms was crossed by a dc electron beam and metastable H(2S) atoms were produced by electron-impact excitation. The H(2S) atoms proceeded downstream with the ground-state atom beam and passed between two parallel plates providing a weak electric quench field. The Lyman-α radiation produced was detected at 90°, and its polarization was examined using a LiF Brewster's-angle-reflector polarization detector, followed by an oxygen-filtered iodine-vapor-filled photon counter. The quenching field ranged from 3 to 15 V/cm. (W.D.M.)

17385 KINETIC ENERGY OF AUTOIONIZATION OF HELIUM. Cohen, Ronald Bruce (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Naturforsch., 22A: 1809-10(Nov. 1967).

The kinetic energy distribution of He^+ and D_2^+ ions formed by electron impact above 60 eV was measured. (M.O.W.)

17386 SCATTERING OF HIGH-ENERGY PARTICLES INCIDENT ON A SOLID AT AN ANGLE CLOSE TO $\pi/2$. Firsov, O. B. Sov. Phys.-Solid State (Engl. Transl.), 9: 1687-90(Feb. 1968). Translated from Fiz. Tverd. Tela, 9: 2145-50(Aug. 1967).

The angular distribution function for fast-atomic-particle scattering from the surface of a solid is calculated as a function of angle for angles of incidence close to $\pi/2$. (auth)

17387 ONE WAY OF REALIZING INFINITE-DIMENSIONAL REPRESENTATIONS OF A GROUP OF ROTATIONS HAVING COMPLEX SPIN BY MEANS OF INTEGRAL FUNCTIONS. Sannikov, S. S. (Inst. of Technical Physics, Kiev). Dokl. Akad. Nauk SSSR, 176: 801-4(Oct. 1, 1967). (In Russian).

New representations $D(\lambda)$ of a group of rotations R_3 corresponding to arbitrary weight values $\lambda = -1/4$ and $\lambda = -3/4$ have been realized by single-valued, integral, analytical functions of a complex variable. The procedure can be extended to representations having an arbitrary value of λ, or a complex value of λ in the general case. Representations with a complex spin (or with a complex angular momentum) are used to describe unstable quantum mechanical systems. Details of the transformation are given. (TTT)

17388 LEVEL-CROSSING INVESTIGATIONS OF THE HYPERFINE STRUCTURE OF ^{117}Sn AND ^{119}Sn IN THE $(5p6s)^3P_1^0$ LEVEL OF THE Sn I SPECTRUM. Brieger, M.; Zimmermann, P. (Technische Univ., Berlin). Z. Naturforsch., 22A: 2001-4(Dec. 1967). (In German).

Using the level-crossing technique the following relations between the hyperfine structure constant A and the g_J value of the $(5p6s)^3P_1^0$ term were determined for both the stable isotopes ^{117}Sn and ^{119}Sn: $A_{117} = -159.57(4)$ mK × $g_J/1.380$; $A_{119} = -167.01(4)$ mK × $g_J/1.380$. From the width of the level-crossing signal a mean lifetime $\tau = 4.5(7) \times 10^{-9}$ sec was deduced. (auth)

17389 INCOHERENT SCATTERING CROSS SECTIONS OF GAMMA RAYS IN Be, C, Mg, AND S. Parthasaradhi, K. (Andhra Univ., Waltair, India). Curr. Sci. (India), 37: 101-2(Feb. 20, 1968).

A subtraction technique for assessing the effect of electron binding on gamma incoherent scattering cross sections and for checking theoretical estimates of the effect was applied to Be, C, Mg, and S for gamma rays in the range from 30 to 130 keV. The technique involves subtracting from the total gamma cross sections the theoretically estimated partial cross sections with the exception of the incoherent scattering cross section. The ratio of the remainder to the free electron scattering cross section is taken as a measure of the effect of electron binding. Both experimental and theoretical values for the ratios were obtained for the four elements considered. (D.C.W.)

17390 LUMINESCENCE INDUCED BY ALPHA PARTICLES IN LIQUID XENON IN AN ELECTRIC FIELD. Dolgoshein, B. A.; Lebedenko, V. N.; Rodionov, B. U. (Moscow Engineering-Physics Inst.). JETP Lett. (USSR) (Engl. Transl.), 6: 224-5 (Oct. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 755-7(Oct. 1, 1967).

The luminescence in liquid and gaseous xenon is described for different values of E/p, where p is the pressure that would be possessed by xenon of given density were it to be an ideal gas at 300°K, and E is the intensity of the constant electric field. (M.O.W.)

17391 THIRD-ORDER CORRECTIONS TO THE PASCHEN–BACK EFFECT. Garszczynski, F.; Swierczynska, L. (Copernicus Univ., Torun, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 813-15(1967).

Nearly all considerations concerning the Zeeman structure of the atomic energy levels are based on the formulae obtained in the first order of the nonrelativistic approximation of the Dirac equation. Since the favorable conditions for observing some small effects of the higher orders exist above all for strong magnetic fields, considerations are restricted to the complete Paschen–Back effect. (W.D.M.)

17392 THE K-SHELL FLUORESCENCE YIELD OF PHOSPHORUS. Pahor, J.; Kodre, A.; Moljk, A. (Stefan Nuclear Inst., Ljubljana, Yugoslavia). Nucl. Phys., A109: 62-4(1968).

The K-shell fluorescence yield of phosphorus was determined as $\omega_K = 0.060 \pm 0.003$, using a wall-less proportional counter with a phosphine admixture to methane as the fluorescent radiator. (auth)

17393 ION SOURCE FOR INTENSE BEAMS OF NEGATIVE HEAVY IONS. Hortig, G.; Mokler, P.; Mueller, M. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys., 210: 312-13(1968). (In German).

A method to obtain well-collimated beams of heavy ions on the basis of secondary ion emission is described. (auth)

17394 A QUANTITATIVE COMPARISON OF ENERGY LOSS SPECTRA OF ELECTRONS IN ALUMINIUM AND POTASSIUM WITH THE DIELECTRIC THEORY. Kloos, T. (Univ., Hamburg). Z. Phys., 210: 303-8(1968). (In German).

The energy loss spectra of 34-kV electrons inelastically scattered by thin foils of aluminium and potassium were measured and compared with loss intensities, calculated by the dielectric theory from the dielectric constants ϵ_1 and ϵ_2 depending on energy. One obtains a good quantitative agreement of the measured spectra with the calculated energy loss intensities. (auth)

17395 FXR DISCHARGE CONTINUUM. Dejke, A.; Handel, S. K. (Univ. of Uppsala). Z. Phys., 210: 259-64(1968).

The continuous radiation from a flash x-ray (FXR) discharge was investigated when anodes made of Be, Al, Ta, W, and U are used. It was found that the heavier materials give rise to the strongest continuum. The continuous radiation in the 7 to 300 Å and 2,000 to 5,000 Å regions were recorded and are shown in spectrograms. (auth)

17396 COLLISION-INDUCED DISSOCIATION OF H_2^+ AND D_2^+ IONS. Vogler, M.; Seibt, W. (Univ., Giessen, Ger.). Z. Phys., 210: 337-60(1968). (In German).

The angular and energy distributions of protons produced by collision-induced dissociations of H_2^+ ions with energies of 10 and 20 keV were measured in a parabola spectrograph. From these measurements the velocity distribution of the protons in the center of mass system of the H_2^+ ion can be calculated. This gives information about the type, the abundance, and the anisotropy of the process involved. The most frequent transitions leading to dissociations are the excitation of the $2p\sigma_u$ state, the ionization of the H_2^+ ion, the transition into the vibrational continuum, and the electron capture into the $1\,^3\Sigma_u^+$ state of the hydrogen. It is shown that the cross section for an electronic transition depends on the velocity of the ion, the distance of the nuclei in the ion, the angle between the internuclear axis and the direction of the primary ion beam, and the excitation energy of the target. The fraction of protons produced by vibrational excitation increases with increasing atomic number of the target. Concerning electronic transitions, D_2^+ ions equal H_2^+ ions of the same velocity. (auth)

17397 DIFFERENCES IN THE ANGULAR DEPENDENCIES OF SPIN- AND SYMMETRY-FORBIDDEN EXCITATION CROSS SECTIONS BY LOW-ENERGY ELECTRON IMPACT SPECTROSCOPY. Rice, J. K.; Kuppermann, Aron; Trajmar, Sandor (California Inst. of Tech., Pasadena). J. Chem. Phys., 48: 945-6 (Jan. 15, 1968). (CALT–532-16).

An electron-impact spectrometer was used to measure the differential cross sections for excitation from the ground state of He to the 2^1S (symmetry-forbidden), 2^3P (spin-forbidden), and 2^3S (symmetry- and spin-forbidden) states relative to that of the 2^1P (allowed) one as a function of angle and impact energy. Data taken from 28 to 57 eV support the following conclusions: the $2^3P/2^1P$ and $2^3S/2^1P$ ratios generally increase with increasing angle, reaching broad maxima that appear to move to higher angles at lower energies; the $2^1S/2^1P$ ratio decreases from 0° to approximately 40° and thereafter increases; lowering the impact energy does not increase the ratios at every angle. (A.G.W.)

17398 ANGULAR DISTRIBUTION OF PHOTOELECTRONS. Cooper, J.; Zare, R. N. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). J. Chem. Phys., 48: 942-3(Jan. 15, 1968).

A simple calculation for determining the differential cross section for photoejection of electrons is outlined. Results of calculations for ejection of a p electron from C^- and O^- show that for an energy of several electron volts close to threshold, the angular distribution of these photodetachment electrons is predicted to peak at right angles to the polarization vector rather than along the polarization vector. Calculated angular distributions for the photodetachment of H^- and O^- are compared with experimental data of Hall and Siegel [J. Chem. Phys., 48: 943-5 (1968)]. (A.G.W.)

17399 THRESHOLD ELECTRON IMPACT EXCITATION OF ATOMS AND MOLECULES: DETECTION OF TRIPLET AND TEMPORARY NEGATIVE ION STATES. Compton, R. N.; Huebner, R. H.; Reinhardt, P. W.; Christophorou, L. G. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 48: 901-9(Jan. 15, 1968). (ORNL-P–3376).

A technique which utilizes SF_6 as a scavenger of low-energy electrons is employed to study the "threshold" excitation spectra of He, N_2, HCl, H_2O, D_2O, and a number of aromatic molecules. For electrons within ~0.03 eV of threshold, it is found that the probability of exciting the 2^3S state of helium is approximately 1.5 times larger than that for the 2^1S state. For HCl all of the optically allowed transitions are observed including a Rydberg series leading to the ionization potential. Temporary negative-ion resonances are observed below the first electronic state for all of the aromatic molecules studied. For benzene, in addition to the optically allowed transitions, the first (3.9 eV) and second (4.7 eV) triplet states are detected, while for naphthalene a new intense level at 5.4 eV as well as the lower triplet states are observed. (auth)

17400 CALCULATION OF EXTENDED HARTREE–FOCK WAVEFUNCTIONS. Kaldor, Uzi (Stanford Univ., Calif.). J. Chem. Phys., 48: 835-7(Jan. 15, 1968).

It is shown that an extended Hartree–Fock (EHF) function, obtained by applying a projection operator $\mathcal{O}$ to a Hartree product ϕ with subsequent optimization, has vanishing matrix elements of the operator $\mathcal{H}$-EI with all its singly excited states. A method for obtaining the EHF function using this property is described. Calculations for the Li atom are reported. (auth)

17401 SCATTERING OF HIGH-VELOCITY NEUTRAL PARTICLES. XV. He–H_2 AND He–D_2. Amdur, I.; Smith, Allan Laslett (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 48: 565-8(Jan. 15, 1968).

Total collision cross sections have been measured for helium atoms with energies between 500 and 1900 eV scattered by room temperature H_2 and D_2. Within the experimental precision of ±2% the cross sections of the two systems are identical. The results have been analyzed to obtain the following average potentials: He–H_2: $V(r) = 12.11r^{-6.07}$eV, 1.44 Å $< r < 1.76$ Å; He–D_2: $V(r) = 12.27r^{-6.06}$eV, 1.45 Å $< r < 1.79$ Å. The measurements are in good agreement with a calculated He–H_2 interaction of Krauss and Mies, suitably averaged over molecular orientation. The effect upon scattering of the anisotropy of the potential is discussed in the light of a classical perturbation theory of small-angle scattering developed by Cross. (auth)

17402 ELECTRON EMISSION FROM A (100) TUNGSTEN SURFACE UNDER PROTON BOMBARDMENT. Ewing, Ronald I. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 166: 324-5 (Feb. 10, 1968).

The yield of electrons from a clean (100) surface of tungsten under bombardment by protons at normal incidence is reported as a function of proton energy in the range 50 to 225 keV. The maximum value of the yield is 1.51 ± 0.03 electrons per incident proton at a proton energy of 125 keV. The yield from the (100) plane surface fell (10 ± 2)% below the yield from a polycrystalline surface. This difference can be attributed to the higher work function of the (100) surface. The tungsten surface was cleaned by flash-heating a single-crystal tungsten ribbon to 2400°K in a vacuum chamber in which the total pressure was about 2×10^{-10} Torr. The yield was measured with the surface at room temperature, about 2 min after the surface was cleaned, while the time for a monolayer of residual gases to form on the surface was greater than 2 hr. (auth)

17403 CALCULATION OF THREE-BODY IONIC RECOMBINATION RATE. Landon, Stephen A.; Keck, James C. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 48: 374-80(Jan. 1, 1968).

The three-body ionic recombination rate at low densities is calculated for a slightly ionized gas by considering that the relaxation of the energy of molecules occurs by a "diffusion" process. The effective conductivity in the equivalent diffusion equation is the second moment of the energy transfer. The moments are derived in closed form using classical mechanics and enable the recombination rate constant to be obtained. The agreement of the results with experimental data is good and suggests that the approach is useful even where relatively large energy transfers are involved. (auth)

17404 IMPROVED QUANTUM THEORY OF MANY-ELECTRON SYSTEMS. III. THE GF METHOD. Goddard III, William A. (California Inst. of Tech., Pasedena). J. Chem. Phys., 48: 450-61(Jan. 1, 1968).

A general method of calculating accurate and useful many-electron wave functions for atoms and molecules has previously been described. This general method besides achieving lower energies than do the Hartree–Fock and unrestricted Hartree–Fock methods still yields an independent-particle interpretation of the many-electron wave function, correctly describes dissociation of molecules and solids, and can be used on systems of any total spin. There are several possible approaches for the general method; here one of these, GF method, which is equivalent to optimizing the orbitals in the unrestricted Hartree–Fock method after spin projection rather than before is described. The detailed equations (the GF equations) for the GF method are derived here for all values of total spin and number of particles. (auth)

17405 UNIFORM SEMICLASSICAL APPROXIMATIONS FOR ELASTIC SCATTERING AND EIGENVALUE PROBLEMS. Miller, William H. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 48: 464-7(Jan. 1, 1968).

The uniform semiclassical wave function of Langer is used to obtain a modified quantum condition. The result has the integral quantum numbers replaced by known, nonintegral constants and gives considerably better results for the example of the quartic oscillator. An approximation for the Franck–Condon factor is obtained, which is qualitatively correct for all values of the parameters involved. The result reduces to the known semiclassical results in the appropriate regions and is uniformly valid in the transition regions. The method used by Carrier for evaluating integrals by the method of stationary phase in the case of more than one point of stationary phase is used to extend the semiclassical scattering amplitude of Ford and Wheeler to include the glory and rainbow regions uniformly. (auth)

17406 TRANSFORMATIONS AND AVERAGING PROCESSES FOR DIFFERENTIAL CROSS-SECTION MEASUREMENTS AT THERMAL ENERGIES. Helbing, Reinhard K. B. (General Dynamics/Convair, San Diego, Calif.). Contract AF49(638)-1730. J. Chem. Phys., 48: 472-7(Jan. 1, 1968).

Theoretical predictions on differential cross sections apply to the center-of-mass system of the colliding particles but not to the laboratory system. In order to compare theoretical results with measurements it is necessary either (a) to approximate the center-of-mass system by a suitable choice of the colliding particles and the region of energy, or (b) to transform the differential cross section from the center-of-mass system into the laboratory system. If the target particles are at rest before collision, this transformation is simple and well known. If the target particles are not stationary before collision, the problem of transformation becomes more difficult, especially if the target particles have a distribution of velocities. Formulas are derived which allow the transformation from the center-of-mass system to the laboratory system (and vice versa). Both elastic and inelastic collisions are treated. In addition, the averaging process over all initial relative velocity vectors is described, i.e., for a given differential cross section in the center-of-mass system, the intensity distribution as measured in the laboratory system is calculated. (auth)

17407 ENERGY DEPENDENCE FOR SINGLE AND DOUBLE IONIZATION BY ELECTRON IMPACT BETWEEN 250 AND 2200 eV. Fiquet-Fayard, Florence; Chiari, Jean; Muller, Francoise; Ziesel, Jean-Pierre (Faculte des Sciences, Orsay, France). J. Chem. Phys., 48: 478-82(Jan. 1, 1968).

A preceding work was completed by studying Rb, Zn, Mg, NH_3, NO, N_2, CO, COS, CS_2, and H_2S. All the results prove that the direct double-ionization cross section (simultaneous ejection of two electrons) can be written as $\sigma \propto E^{-1}$, where E is the energy of incident ions. When doubly charged ions are formed, not by direct ionization but by the Auger effect, departure from an E^{-1} dependence was observed. Experiment shows that molecular ions COS^{++}, CS_2^{++}, H_2S^{++}, and NH_3^{++} can be formed by the Auger effect. Discussion suggests that some of these ions are stable only in excited states. Furthermore, the experiments show that for all studied species, excepting magnesium, the single-ionization cross section satisfies the usual dependence $\sigma \propto E^{-1} \log BE$, where B has a reasonable value. The magnesium cross section decreases anomalously rapidly and a satisfactory interpretation of these phenomena was not found. (auth)

17408 REACTION MATRIX METHOD FOR COMPUTING PROBABILITIES OF VIBRATION–TRANSLATION ENERGY TRANSFER. Weare, John H.; Thiele, Everett (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 48: 513-14(Jan. 1, 1968).

Vibrational transition probabilities induced by the collinear collision of a harmonic oscillator and an atom interacting via an exponential repulsive potential were calculated by a reaction matrix formalism. The essential feature of this formalism is the rigorous satisfaction of the physical requirement of particle conservation. A comparison of these results with results of other methods indicates that this method offers an extended range of applicability for one-quantum transition-probabilities and an improvement in multiple-quantum probabilities. (A.G.W.)

17409 SECONDARY ELECTRON EMISSION BY ARGON ATOMS AND IONS FROM A GAS-COVERED SURFACE. Haugsjaa, Paul O.; McIlwain, John F.; Amme, Robert C. (Univ. of Denver). J. Chem. Phys., 48: 527-8(Jan. 1, 1968).

Beam energies of approximately 40 eV to more than 1 keV were used to investigate the efficiency of charged and neutral species in ejecting secondary electrons from metallic surfaces. Gold foils cleaned to simulate ordinary laboratory conditions were used. A plot of measured secondary-electron-emission coefficients vs beam energy for neutral argon atoms shows a relatively high coefficient at 40 eV and a pronounced step in the vicinity of 80 eV. Possible explanations for this structure are considered. Results for argon ions were not obtained below 140 eV. (A.G.W.)

17410 HELIUM ION–HYDROGEN REACTIONS. Rozett, R. W.; Koski, W. S. (Johns Hopkins Univ., Baltimore). Contract AF49(638)-1301. J. Chem. Phys., 48: 533-4(Jan. 1, 1968).

Results are reported of some cross-section measurements of the process $X^+ + AB \rightarrow X + A^+ + B$ in which $X = He^+$ and $AB = H_2$ or HD at ion energies of 12 to 48 eV. The cross sections are several orders of magnitude lower than would be expected from the Langevin model and increase with bombarding ion energy. It is noted that in the HD reaction, protons are more numerous at low energies and deuterons more abundant at higher energies. A high product kinetic energy seems characteristic of the reaction. It is suggested that the most likely mechanism for the dissociative charge-transfer reaction is a nonresonant charge to the repulsive ${}^2\Sigma_\mu^+$ state of H_2^+ with consequent dissociation of the molecular ion into an atom and an ion. (A.G.W.)

17411 $He–Li^+$ INTERACTION ENERGY AT SMALL INTERNUCLEAR DISTANCES. Fischer, C. R. (Brookhaven National Lab., Upton, N. Y. Queens Coll. of the City Univ. of New York, Flushing). J. Chem. Phys., 48: 215-17(Jan. 1, 1968). (BNL–11596).

A single-configuration MO–SCF calculation of the $He–Li^+$ interaction energy in the Born–Oppenheimer approximation for internuclear separations between 0.1 and 0.7 Å is found to be in disagreement with the same interaction deduced by Zehr and Berry from atomic scattering data. The calculated/experimental ratio for the energy is approximately 1.4 for $0.21\ Å < r < 0.74\ Å$. The MO–SCF potential may be presented to within 10% by the Born–Mayer form as $V(r) = 580 \exp(-5.4r)$ eV with r in Å. It is shown that the discrepancy cannot be accounted for by the neglect of correlation energy associated with the single-configuration MO type of calculation. (auth)

17412 RETARDED INTERACTION ENERGIES BETWEEN LIKE ATOMS IN DIFFERENT ENERGY STATES. Meath, William J. (Univ. of Western Ontario, London. Univ. of Wisconsin, Madison). J. Chem. Phys., 48: 227-35(Jan. 1, 1968).

The long-range interaction energy between two like atoms in different energy states is discussed in general, through $O(\alpha^2)$, using the Breit–Pauli approximation. Selection rules are derived for possible interactions where retardation or relativistic effects may be important. The S–P resonant interaction is considered as a specific example. The interaction energies for the resulting Σ and Π molecular states are calculated in both the Breit–Pauli approximation and from the exact dipole–dipole results of McLone and Power, Stephen and others. The R^{-1} expansion of the exact result and the validity of the Breit–Pauli approximation are discussed in detail. The interaction energies are also compared with the linewidths for the various molecular states. It is shown that the Breit–Pauli approximation can give a good representation (especially for the Σ states) of the interaction for quite large values of $R \gtrsim ƛ$, where ƛ is the characteristic wavelength for the S–P transition. (auth)

17413 He–He INTERACTION IN THE SCF–MO APPROXIMATION. Kestner, Neil R. (Louisiana State Univ., Baton Rouge). J. Chem. Phys., 48: 252-7(Jan. 1, 1968).

The interaction of the two helium atoms between 1 and $6a_0$ has been calculated using the homonuclear diatomic SCF program of the Laboratory of Molecular Structure and Spectra at the University of Chicago. Adequate results are obtained when the basis set consists of three s-type and one p-type atomic functions on each center. The Hartree–Fock energy of the He_2 system is always greater than that of two helium atoms. (auth)

17414 MULTIPLE SOLUTIONS TO THE HARTREE–FOCK PROBLEM. I. GENERAL TREATMENT OF TWO-ELECTRON CLOSED-SHELL SYSTEMS. Stanton, Richard E. (Canisius Coll., Buffalo, N. Y.). J. Chem. Phys., 48: 257-62(Jan. 1, 1968).

The number of fully self-consistent, closed-shell solutions to the two-electron Hartree–Fock problem is investigated. With N orbital basis functions the Hartree–Fock wave function can be expanded as a superposition of $N(N + 1)/2$ configurations. The constraints in the coefficients are analyzed exactly for the case $N = 2$. The free CI problem corresponds to finding energy extrema on the surface of a sphere. The Hartree–Fock state point is constrained to lie on a circle on this sphere. There will be two, three, or four SCF solutions depending on the manner in which the circle of constraints crosses valleys and ridges on the sphere. This is shown explicitly by detailed calculations for the He atom. These calculations also reveal instances in which aufbau method of solution necessarily diverges. The general problem can be analyzed under the assumption of zero differential overlap. The Hartree–Fock matrix is diagonal in this approximation, but the diagonal elements still involve the orbital coefficients. One can set an upper limit of $(3^N - 1)/2$ to the number of acceptable solutions for this problem. (auth)

17415 TEMPERATURE DEPENDENCE OF POSITRON LIFETIME IN WATER. Jauho, P.; Virnes, M. (Technical Univ. of Helsinki). Phys. Lett., 26A: 208-9(Jan. 29, 1968).

According to measurements of this experiment, the long lifetime τ_2 of positrons in water shows a sudden transition at about 4°C. The transition in the peak rate of angular correlation of annihilation photons is situated at 0°C. (auth)

17416 STOPPING POWER AND THE ADDITIVITY RULE FOR SOME FLUORINE COMPOUNDS. Bewers, J. M.; Flack, F. C. (Univ. of Exeter, Eng.). Nucl. Instrum. Methods, 59: 337-8(Feb. 1968).

Experiments with 1-MeV protons bombarding sixteen different fluorine compounds show that, within 2%, the stopping power of a compound is given by the sum of the atomic stopping powers of the constituent atoms. (auth)

17417 INFORMATION ON THE ${}^1\Sigma^+$ AND ${}^3\Sigma^+$ POTENTIALS OF NaCs FROM TOTAL SCATTERING CROSS-SECTION MEASUREMENTS. Neumann, W.; Pauly, H. (Univ., Bonn). Phys. Rev. Lett., 20: 357-9(Feb. 19, 1968).

The velocity dependence of the total elastic cross section for the scattering of a fast Na atomic beam by a thermal-energy Cs beam has been investigated in the energy range 14 to 2300 eV. Detailed information on the interatomic potential for both the singlet and triplet state of NaCs has been obtained from an analysis of the experimental data. (auth)

17418 POSSIBILITY OF THE FORMATION OF THE MUONIUM WATER MOLECULE. Kim, Y. N. (Texas Technological Coll., Lubbock). Phys. Rev. Lett., 20: 359-60(Feb. 19, 1968).

The possibility of the formation of muonic water molecules (μHO) and their probable fundamental vibrational frequencies is discussed. (M.O.W.)

17419 CROSS SECTION AND POLARIZATION OF THE H_α LINE BY ELECTRON IMPACT EXCITATION. Kleinpoppen, Hans (National Bureau of Standards, Boulder, Colo. Univ. of Colorado, Boulder); Kraiss, Eberhard. Phys. Rev. Lett., 20: 361-3(Feb. 19, 1968).

The modulated cross-beam technique has been used to measure the excitation function and the polarization of the Balmer-α line of atomic hydrogen excited by electron impact. Normalization of the H_α excitation function to the Born approximation above 300 eV provides cross sections in the energy range from the threshold up to 350 eV. The polarization of the H_α line shows an abrupt decrease, which is contrary to the "normal" behavior of increasing polarization up to the threshold observed for the alkali atom resonance line. (auth)

17420 CALCULATION OF THE ENERGY-LOSS DISTRIBUTION FOR CHANNELED PARTICLES. Poizat, J. C.; Remillieux, J.; Sarazin, A. (Univ., Lyon). Nucl. Instrum. Methods, 59: 333-6(Feb. 1968). (In French).

The shape of the spectra of fast channeled particles transmitted through a single crystal is computed. A simplified channel-model is described. Results give, in particular, an explanation of the high energy loss component of the observed spectra. (auth)

17421 LOCATION OF SHOULDERS IN CHANNELING PHENOMENA. Barrett, J. H. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 166: 219-21(Feb. 10, 1968). (ORNL-P-3450).

A Monte Carlo computer program for use in calculating channeling effects has been written. It incorporates a model of lattice vibrations in which the lattice atoms vibrate independently of each other. The position of the shoulder for a planar channel is predicted quite well by the breakthrough angle for trajectories in the channel. The position of the shoulder of a row channel is found to be determined by the shoulders of the several planar channels intersecting at the row channel. The breakthrough angle for rows appears to mark a rather sharp boundary between orientations in which row or planar effects predominate. (auth)

17422 ELECTRIC MULTIPOLE INTERACTIONS BETWEEN RARE-EARTH IONS. Wolf, W. P.; Birgeneau, R. J. (Yale Univ., New Haven). Phys. Rev., 166: 376-82(Feb. 10, 1968). (TID-23952).

In calculations of electrostatic coupling effects between rare-earth ions, it is generally assumed that the electric quadrupole-quadrupole term is much larger than the corresponding interactions between higher-degree multipole moments. It is pointed out that the relative importance of the higher-degree terms may be enhanced by electrostatic shielding and induced-moment effects similar to those affecting single-ion crystal-field terms, and the Hamiltonian operators are derived or the l-l′ multipole interactions up to sixth degree. Comparison with the observed single-ion crystal fields also suggests that electric multipole interactions might be relatively important throughout the rare-earth series and not only for the larger light ions, as is often assumed. For pairs of Kramers ions at low temperatures ($S' = 1/2$), the various multipole interactions will contribute in second order to different terms of an effective spin Hamiltonian of the form $S_i' \cdot K \cdot S_j'$, and the resulting interaction tensor K will generally be quite anisotropic, subject only to symmetry. There is also a corresponding anisotropic contribution to the magnetic g tensor, whose principal values and axes may thus be different from those of the single ions. Detailed multipole calculations are prohibitively complicated in the general case, and unless it can be shown that the higher-degree terms are in fact negligible, the observable interaction parameters in any particular case must therefore be treated as strictly empirical quantities, restricted only by symmetry. (auth)

17423 ABSOLUTE CROSS SECTION FOR ELECTRON IMPACT EXCITATION OF 3914 A N_2^+. McConkey, J. W.; Woolsey, J. M.; Burns, D. J. (Queen's Univ., Belfast). Planet. Space Sci., 15: 1332-4(Aug. 1967).

Absolute measurements with a quartz—iodine standard lamp and calibrated gas-filled tungsten filament lamp are reported, which are not open to the criticisms leveled at the earlier work of McConkey and Latimer [Proc. Phys. Soc., 86: Pt. 3, 463-6 (Sept. 1965)]. New measurements of the maximum cross section using the earlier indirect calibration technique are also mentioned. A graph shows these results in comparison with those of other workers, and a further graph compares the authors' electron impact observations with the proton impact data of Robinson and Gilbody (not yet published), showing the agreement expected at high energies where the first Born approximation is valid. (UK)

Cosmic Radiation

Refer also to abstracts 16875, 17207, 17209, 17248, 17249, 17310, 17850, 17862, and 17896.

17424 THE 0.5-MeV GAMMA-RAY FLUX AND THE ENERGY LOSS SPECTRUM IN CsI(Tl) AT 4g/cm². Chupp, E. L.; Sarkady, A. A.; Gilman, H. P. (Univ. of New Hampshire, Durham). Planet. Space Sci., 15: 881-92(May 1967).

An experiment is described which was designed to study the time variation of the 0.5 MeV gamma-ray line at small atmospheric depths. The experiment was flown from Palestine, Texas on April 6, 1966, and yielded an equivalent omnidirectional flux of 0.29 ± 0.04 photons cm^{-2} sec^{-1} at an atmospheric depth of 4.0 ± 0.3 g/cm² for the line at 0.5 MeV, as well as the continuous energy loss spectrum in a CsI gamma-ray spectrometer from 0.2 to 0.9 MeV. An additional feature, nominally at ~0.70 → 0.75 MeV, was significantly present in the spectrum, corresponding to an equivalent omnidirectional flux of 0.10 ± 0.02 photons cm^{-2} sec^{-1}, at 4 g/cm². The results are compared with a similar measurement in 1961, and it is found that the total flux of 0.5 MeV gamma rays in 1966 is about a factor of two larger than expected, if it is assumed that this radiation is solely a result of interactions of charged primary cosmic rays in the atmosphere and follows the modulation of ion-chamber intensity. Possible explanations of this discrepancy are discussed. Since atmospheric nuclear detonations may contribute to the observed features of the spectrum, it is necessary to consider the possibility that the 0.5 MeV line, sometimes attributed to e^+-e^- annihilation radiation, may have a significant time-varying contribution from other sources. These include nuclear debris gamma rays from $^{106}Ru \rightarrow ^{106}Pd$ with energies of 0.51 MeV and 0.62 MeV; and $^{103}Ru \rightarrow ^{103}Rh$ with an energy of 0.49 MeV. Gamma rays with an energy of 0.48 MeV from naturally occurring ^7Be, which is produced by cosmic-ray interactions in the atmosphere, may also contribute. Further experiments and improved instrumentation are required before definitive knowledge can be obtained concerning the high-altitude flux of annihilation photons or the detailed nature of the gamma-ray spectrum in the energy region from 0.2 MeV to 0.9 MeV. (auth) (UK)

17425 MEASUREMENT OF PRIMARY AND ALBEDO COSMIC RAYS ON A POLAR ORBITING SATELLITE. Murayama, Takashi (Univ. of Chicago). Planet. Space Sci., 15: 1169-80(July 1967).

Relative contributions of primary cosmic ray splash albedo and re-entrant albedo fluxes were evaluated from the altitude dependence of measurements with a triple coincidence counter telescope on board the satellite Discoverer 29 in a polar orbit in 1961. The results were: 75% primary cosmic rays and 25% splash albedo at an altitude of 165 km over polar regions, and 62% cosmic rays, 24% splash albedo and 14% re-entrant albedo at 180 km near 60° geomagnetic latitude. The local time dependence of the re-entrant albedo flux was studied, and the flux on the day side of the Earth was found to be higher than that on the night side. This effect appears to be a consequence of the distortion of the geomagnetic field due to the solar wind. The variation of interplanetary cosmic ray integral flux above 100 MeV with solar activity over the years 1959—1961 was also studied. (auth) (UK)

17426 MEASUREMENT OF THE PRIMARY COSMIC-RAY α PARTICLES BY THE USE OF A BALLOON. I. Kondo, Ichiro; Sakai, Kosuke (Nagoya Univ., Japan). Tokyo Daigaku Uchu Koku Knekyusho Hokiku, 3: 433-47(June 1967). (In Japanese).

Phenomena in interplanetary space are studied by measuring the 11-year change of cosmic-ray α-particle intensity. A balloon experiment was carried out to investigate the performance of the measuring instruments employed, and to examine the secondary cosmic-ray backgrounds in the atmosphere. The following conclusions were drawn from the analysis of the obtained experimental results. (1) The background for the α-particles can be held within about 10% by using the correlation between the pulse-heights from two scintillation detectors and that from one Cherenkov detector. The value of the α-particle intensity at the top of the atmosphere, obtained in this manner, is 27.1 ± 2.1/m² str sec, agreeing with those previously reported. Using only two detectors, the background is 30 to 40%, and it becomes necessary to use a side shower detector. (2) The maximum in the intensity of atmospheric secondary particles, particularly splash albedo, can be obtained from the data of Cherenkov detectors. Assuming the return-albedo intensity to be approximately equal to that of splash albedo, it seems that the difference in the intensity of the charged particles and of the primary cosmic-ray particles, at the top of the atmosphere, can mostly be explained. (NSA of Japan)

17427 CONFINEMENT OF COSMIC-RAY NUCLEI IN IONIZED SOURCE REGIONS AND INTERSTELLAR MEDIUM. Durgaprasad, N. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 1583-91(Mar. 1, 1968).

The problem of delineating the effects of the matter traversed by cosmic rays in the source region (which consists of matter in the ionized state) and in the interstellar medium (which is partially ionized) is investigated in great detail by studying the energy losses suffered by a charged particle in these two media. Expressions for the energy losses are derived from a consideration of the composition of neutral and ionized atoms in these media. The relative intensities of the nuclei of various energies and charges are then calculated for different path lengths traversed in such source regions and in space, taking both the effects of ionization loss and fragmentation in the media concerned. Three kinds of source spectra, namely power law spectra in total energy per nucleon, in kinetic energy per nucleon, and in rigidity, are used for this purpose; the exponents and other constants involved in these spectra are deduced from the high-energy data that are little affected by solar modulation. The inplications of these calculations are discussed with reference to experimental results on the ratio of intensities (1) $\Gamma_{H1\alpha}$ of H_1 nuclei ($Z \geq 20$) to α particles, (2) $\Gamma_{H\alpha}$ of H nuclei ($Z \geq 10$) to α particles, and (3) Γ_{LS} of L nuclei ($Z = 3 - 5$) to S nuclei ($Z \geq 6$) in the energy region 50 to 1000 MeV per nucleon. It is concluded that for similar source kinetic energy per nucleon and rigidity spectra, the effect of the matter traversed by particles in the source region is negligible compared to its value in the interstellar space. On the other hand, for a source spectrum that is a power law in total energy per nucleon the experimental results would indicate an appreciable trapping of the particles in the source region itself. (auth)

17428 ARRIVAL OF LOW-ENERGY COSMIC RAYS VIA THE MAGNETOSPHERIC TAIL. Gall, Ruth; Jimenez, Jaime; Camacho, Lucilla (Univ. Nacional Autonoma de Mexico, Mexico City). J. Geophys. Res., 73: 1593-1605(Mar. 1, 1968).

The role the external current responsible for the magnetospheric tail plays at quiet times in the penetration, motion, and arrival of low-energy cosmic rays is deduced from the integration of 1- to 500-MeV proton trajectories in a model magnetosphere. Using the Williams and Mead model, it is shown that protons can reach the midnight side at latitudes between 60 and 69° and the day side at latitudes between 60 and 80° by way of the tail. Protons have direct access to higher latitudes along open field lines. Thus, for latitudes above 60°, the cutoffs are lowered below the internal field cutoff values. No such lowering occurs for latitudes below 60° because the field lines in this region are not appreciably affected by the external current responsible for the tail. A daily cutoff variation, the minimum rigidity trajectories coming from the night side for any local time of arrival, is found. The directions of approach along which the low-energy cosmic rays cross the magnetopause en route to the station show a variation with local time. The daily variation in cutoff and approach directions are induced by axial asymmetry of the geomagnetic cavity. (auth)

17429 GENERATION OF COSMIC RAYS DURING SMALL CHROMOSPHERIC BURST AS A FUNCTION OF SOLAR ACTIVITY. Ivanov, V. I.; Kolomeets, E. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1833-4(Nov. 1966). (In Russian).

The effect of "small" chromospheric bursts on cosmic rays was analyzed on the basis of data reported by the worldwide network for the period from 1959 to 1964, inclusive. The diurnal solar variation was taken into account by deducting the sum of the first and second harmonics calculated from the same data. Neutron intensity values obtained during and after chromospheric bursts showed that during the period of 1959–60, the intensity increased whenever the detector was located outside of the zone of incidence. This zone may be clearly distinguished during the following years and during the minimum of solar activity. Study of the neutron component data collected by the worldwide network of stations during chromospheric bursts revealed that bursts at the equatorial regions at the Sun during the maximum of solar activity affect the increase of the neutron intensity more than those occurring at higher latitudes. It was also found that the bursts in the western hemisphere of the Sun are more effective than those occurring in the eastern hemisphere. The 1957–58 data yielded similar results. (TTT)

17430 THE PRIMARY COSMIC-RAY ELECTRON ENERGY SPECTRUM FROM 10 TO 40 MeV. Fan, C. Y.; Gloeckler, G.; Simpson, J. A.; Verma, S. D. (Univ. of Chicago). Astrophys. J., 151: 737-41(Feb. 1968).

The differential energy spectrum of primary cosmic-ray electrons in the energy range 10 to 40 MeV was measured on the IMP-III satellite during the period of minimum solar modulation for galactic cosmic rays. The average flux was found to be 3 ± 2 electrons/(m^2sec sterad MeV) and the differential energy spectrum joins previous measurements made at lower and higher energies. (auth)

17431 EVOLUTION OF ELEMENT ABUNDANCES IN GALACTIC COSMIC RAYS. Beck, F. (Institut d' Astrophysique, Paris); Yiou, F. Astrophys. Lett., 1: 75-83(Jan. 1968).

Recent measurements of spallation cross sections, together with recent statistical studies of the spallation process in light nuclei, were used to reanalyze the chemical evolution of high-energy galactic cosmic rays in their path across interstellar matter. ($\epsilon > 1.5$ GeV/nucleon). The amount of matter traversed is found to be 5.5 g/cm^{-2} (slightly larger than previously determined). The initial abundances of Fe, Si, Mg are somewhat larger than the universal abundances. The hypothesis of pure iron injection appears highly improbable. The even–odd abundance effect is well reproduced. Indications are that ^{7}Be does not decay (by electronic capture) throughout its journey in space. Because of its low formation cross section, it is difficult at the present time to use ^{10}Be to date the galactic cosmic rays. (auth)

17432 SECONDARY COSMIC-RAY ELECTRONS PRODUCED IN INTERSTELLAR MEDIUM. II. THE SECONDARY ELECTRON EQUILIBRIUM SPECTRUM IN THE GALAXY. Perola, G. C.; Scarsi, L.; Sironi, G. (Univ., Milan). Nuovo Cim. (10), 53B: 459-70(Feb. 11, 1968).

The galactic secondary-electron energy spectrum and charge-sign ratio are calculated in the framework of two models involving respectively the galactic disc and the galactic disc + halo as confinement volume for the cosmic-ray charged particles. The expected equilibrium differential energy spectrum and charge composition are given in detail for different values of the confinement time in both models and confronted with the existing experimental information. (auth)

17433 X-RAY FLUX AND ANISOTROPY PRODUCED BY GALACTIC COSMIC-RAY ELECTRONS. Maraschi, L.; Perola, G. C.; Schwarz, S. (Univ., Milan). Nuovo Cim. (10), 53B: 443-58(Feb. 11, 1968).

The galactic contribution to the diffuse X-ray flux is calculated on the basis of working hypotheses as to the shape of the electron spectrum in interstellar space. The galactic contribution is found to be small if compared with the observed X-ray intensity; nevertheless, it may cause an appreciable anisotropy which would give information on the true cosmic-ray electron spectrum at low energies (below 10 MeV) in interstellar space. (auth)

17434 CHARGE COMPOSITION OF COSMIC-RAY ELECTRONS. Bland, C. J. (Univ., Milan). Planet. Space Sci., 15: 398-9(Feb. 1967).

Comments are made on Axford's discussion [Planet. Space Sci., 14: 652-4(July 1966)] of deductions from experimental observation and Meyer's energy spectrum [Proc. Int. Conf. Cosmic Rays, London Vol. 1, 61-7(1965)]. The inadequacy of present experimental evidence is underlined, and attention is drawn to effects, hitherto neglected, of secondary electron fluxes at the level of balloon observation. The author cites his own measurement [Phys. Rev. Lett., 17: 813-16(Oct. 10, (1966))] of positron proportions, and looks to satellite experiments to substantiate the general opinion on the relative importance of primary and galactic secondary sources. (UK)

Direct Energy Conversion

17435 (MMM-3824-0017) SNAP-23A PROGRAM, PHASE I. THERMOELECTRIC CONVERTER DEVELOPMENT PROGRAM. Quarterly Report No. 4, October 1, 1967–December 31, 1967. Wachenheim, J. V. (Minnesota Mining and Mfg. Co., St. Paul). Contract AT(30-1)-3824. 137p. Dep. CFSTI.

During this quarter, fabrication and final assembly of the first Experimental Mockup Converter was completed. The unit was placed on test for a nominal 500-hour period after which shipment will be made to Westinghouse for system integration early in the next quarter. Power output of the first 60-watt converter was below the predicted value. An investigation was started to determine the cause. As an interim measure, plans were made to change the basic thermocouple design configuration to include bonded type P-legs in Experimental Mockup Converter No. 3. This has undergone extensive testing in the SNAP-23A 10-Couple Module Test Program and in the related SNAP-21 Program, Contract AT(30-1)-3691. Heat transfer improvements are required at the spherical cold electrode-to-follower interface in order to reduce temperature drop to the specification level of 30°F maximum. Two approaches have been investigated and have the required capability: use of indium foil at the spherical interface with existing aluminum hardcoated followers, and use of beryllium oxide followers. The first approach will be implemented in Experimental Mockup Converter No. 3, and the latter approach is under investigation for application on the Prototype Mockup Converters. Beryllium oxide material exhibits the ultimate combination of electrical resistance and heat transfer characteristics for the application. (auth)

17436 A STUDY ON THE THERMODYNAMIC AND ELECTRICAL PROPERTIES OF A BURNING GAS AND ITS PLASMA. I. THE THEORETICAL CALCULATIONS. Mori, Yasuo (Tokyo Inst. of Tech.); Otake Kazutome; Yamamoto, Mitsuyoshi. Nippon Kikai Gakkai Rombunshu, 33: 1239-50(Aug. 1967). (In Japanese).

Theoretical calculations were made on various thermodynamic and electric properties of the burning gas plasmas of petroleum (C_nH_{2n}) and coke (C) in which K_2SO_4 or KOH were added to the equilibrium gases. The ranges of experiments were temperatures 0 to 4000°K, pressures 0.2 to 8.0 atm, equivalent ratios 0.8 to 1.5, N_2/O_2 ratios 0 to 79/21 (air), and added K_2SO_4 ratios K/C = 0.02 to 0.4. The results obtained are as follows. (1) For the ranges of temperature and pressure, necessary for the calculation of the performance of an MHD dynamo, the i–s curves were plotted for various combinations of a fuel and an oxidizing agent. As the temperature and also the O_2 concentration are increased, the enthalpy is rapidly increased due to the thermal dissociation. (2) The specific heat at constant pressure increases with the increasing O_2 concentration, for the same temperature and pressure. In the case of the frozen components, the rate of increase in the specific heat (at constant pressure) with the temperature becomes fairly small due to the absence of the influence of dissociation heat. (3) The adiabatic temperature of a flame, for various N_2/O_2 ratios, was calculated, changing the equivalent ratio. In all cases, the highest temperature appears on the side of an excess fuel, compared with the theoretical mixing ratio, and this point moves somewhat to the excess-fuel side as the O_2 concentration is increased. (4) In the calculation of the electrical properties, K_2SO_4, K_2CO_3, K_2O_2, and KO were added to the conventional KOH, K, and K^+. It was shown that there are almost no differences in the electron density, electrical conductivity and Hall coefficient between the present and the conventional calculations above 3000°K, but there are considerable differences below 2500°K. (NSA of Japan)

17437 INFLUENCE OF THE ANODE EMISSION ON THE MAXIMUM EFFICIENCY OF THE THERMIONIC DIODE ENERGY CONVERTER. Urbaniec, K.; Zgorzelski, M. (Instytut Techniki Cieplnej, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech., 15: 181-5(1967).

The main features of theoretical work performed to obtain information about the influence of back emission on the efficiency of the thermionic diode energy converter are summarized. The equations determining the energy losses and the efficiency of the converter are derived along with the equations determining the optimal operation of the cesium diode. It is possible to reduce the system of equations to a transcendental equation which may be used to calculate the optimal density of the cathode emission current. (IAA)

17438 ENERGY SUPPLY AND ENERGY CONVERTERS IN SATELLITES AND SPACE VEHICLES. Peschka, W. (Institut fuer Energiewandlung und Elektrische Antrieb, Stuttgart). VDI (Ver. Deut. Ing.) Z., 109: 572-4(1967). (In German).

Discussion of electric power systems for use on board satellites and space vehicles. The requirements for such a system are outlined and examined in application to such energy sources as fuel cells (particularly the H_2-O_2 cell employing an ion-exchange membrane as the electrolyte), radioisotopes, and nuclear reactors. The current status of energy converters is reviewed, with particular reference to solar cells, electromechanical, thermionic, thermoelectric, and inductive MFD converters. (IAA)

17439 ELECTROMAGNET FOR AN EXPERIMENTAL DC MHD GENERATOR. Kutnohorsky, Vladimir (Vysoke Uceni Technicke, Brno). Elektrotech. Obz., 56: 178-84(Apr. 1967). (In Czech).

The design of an electromagnet for use in an MHD generator is discussed. A procedure for calculating the thermal and magnetic characteristics of the electromagnet is proposed and verified experimentally. (auth)

17440 STATUS REPORT ON MHD ELECTRICAL POWER GENERATION. Nucl. Fusion, 7: 267-87(Dec. 1967).

The present status of commercial large-scale MHD electrical power generation is reviewed in the light of information presented at the Third International Symposium on MHD Electrical Power Generation (Salzburg, 1966) and of subsequent developments. Research and development activities, and the state of evaluation of engineering and economic factors are assessed in respect of open-cycle MHD power plant, closed-cycle MHD power plant, and the associated electromagnet. (M.O.W.)

17441 MAGNETOHYDRODYNAMIC PULSE GENERATOR WITH A SUPERCONDUCTING MAGNETIC SYSTEM. Kirillin, A. E.; Sheindlin, A. E.; Asinovskii, E. I.; Sychev, V. V.; Zenkevich, B. V.; Maksimov, A. M.; Al'tov, V. A. (Inst. of High Temperatures, Moscow). Dokl. Akad. Nauk SSSR, 177: 77-80(Nov.-Dec. 1967). (In Russian).

In view of the need for electric energy sources which are able to develop up to several hundreds of megawatts within a few milliseconds, the magnetohydrodynamic pulse generator which transforms the mechanical energy of bursts into electrical energy was studied, investigating the possible effective utilization of superconductors. An electric discharge shock tube with a conic discharge chamber was used to test the channel of the MHD generator, reaching a maximum energy of 11 kJ with a battery of 6 condensers. The superconducting magnetic system consisted of 0.27-mm-diameter filaments of a ternary niobium–zirconium–titanium alloy. Propagation of the shock wave and the gas-discharge plasma was determined by means of 3 pairs of photomultipliers. The velocity of the shock waves in the channel was found to be about 5 km/sec. The peak power reached lies between 10 and 100 kW. About 100 startups were made during the 12 hours of the tests. The results indicated that design of a magnetohydrodynamic pulse generator with an autonomous superconducting magnetic system is feasible. (TTT)

17442 HEAT TRANSFER APPARATUS. (to Nuclear Materials and Equipment Corp.). British Patent 1,103,085. Feb. 14, 1968. Priority date Dec. 3, 1964, United States.

Heat transfer apparatus is described which includes a heat source and a heat sink. A yieldable thermal contact means is in heat-interchange relationship with the heat source. A second yieldable thermal contact means is in heat-interchange relationship with the heat sink. Resilient capillary means are in engagement with the first and second contact means urging the first contact means into firm thermal engagement with the heat source and the second contact means with the heat sink. A material is between the contact means which in liquid phase is at one temperature and in vapor phase is at a second temperature higher than the first. The first contact means is maintained at the second temperature and the second contact means is maintained at the first temperature. This material in liquid phase flows between the second contact means and the first contact means by capillarity. The apparatus is in an enclosure with the vapor. (M.H.R.)

17443 THERMOELECTRIC ASSEMBLY. (to Nuclear Materials and Equipment Corp.). British Patent 1,103,086. Feb. 14, 1968. Priority date Dec. 3, 1964, United States.

The thermoelectric assembly described includes a first thermoelectric element in the form of a first solid block and a second thermoelectric element, of the same thermoelectric type as the first element, in the form of a second block. This second block has appreciably different electrical properties from the first block. The second block has a surface in electrical current transfer engagement with a corresponding surface of the first block. The second block has in its surface a hollow region dimensioned to compensate for the differences in the electrical properties. The outer peripheries of the surfaces of engagement of the blocks are congruent. The assembly includes a heat source and a heat sink. One of the blocks is connected with the heat source and the other with the heat sink. (M.H.R.)

17444 METHOD AND DEVICE FOR SUPPLYING A MAGNETOHYDRODYNAMIC GENERATOR. Karr, C. (to Commissariat a l'Energie Atomique. Institut Francais du Petrole). Canadian Patent 768,861. Oct. 10, 1967. Priority date Feb. 8, 1964, France.

A device is described to create hot zones and cold zones without producing any modulation of either velocity or pressure within the combustion chamber which would later result in the rapid mixing of these zones. There are two ducts which supply two separate fuel mixtures of different compositions to the combustion chamber. A rotary disc puts each duct into communication with the combustion chamber in alternate sequence so that the magnetohydrodynamic generator is supplied with a temperature modulated gas. A temperature difference, without pressure disturbances, between the hot and cold zones of 300 to 1000°K is achieved by adjusting the proportion of fuel and oxidant in each duct with preheating as required. (F.S.A.)

Fluid Physics

Refer also to abstract 17246.

17445 (SC-RR-67-865) SIMILAR SOLUTIONS FOR UNSTEADY ONE DIMENSIONAL FLOW OF A CONDUCTING FLUID WITH POROUS BOUNDARIES. Sluyter, Marshall M. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 14p. Dep. CFSTI.

Similar solutions are obtained for the Couette flow of an incompressible, electrically conducting fluid under the combined time-dependent actions of a transverse magnetic field and a transverse velocity, i.e., suction or injection, through the boundaries. For the case studies, the magnetic field affects the time scale of the flow, and from a qualitative point of view the problem can be reduced to a viscous-only case. (auth)

17446 (TN-PH-4-66) MAGNETOHYDRODYNAMIC TRANSPIRATION COOLING. Rudraiah, N. (National Aeronautical Lab., Bangalore (India)). Oct. 1966. 14p.

The problem of transpiration cooling between two porous concentric spheres with an electrically conducting viscous incompressible steady fluid as coolant and with different applied magnetic fields in the θ direction is discussed. It is assumed that the fluid is either ejected through the porous walls into the main flow or is removed from the main flow by suction. The properties of the fluid both in the main flow and in passing through the porous walls are assumed constant and identical. To determine the effect of magnetic field on the temperature and pressure, the flow equations were made dimensionless and the solutions expressed in terms of the dimensionless parameters, Hartmann number, Reynolds number, Eckert number, Peclét number, and Stuart number. The temperature and pressure distributions are obtained. It was found that the magnetic field has considerable effect on the pressure coefficient, temperature and heat transfer coefficients. (auth) (STAR)

17447 SLIP FLOW AROUND A SPHERE ROTATING STEADILY IN CONDUCTING FLUID UNDER TRANSVERSE MAGNETIC FIELD. Datta, S. (Lucknow Univ., India). Bull. Acad. Pol. Sci., Ser. Sci. Tech., 15: 665-70(1967).

It is assumed that the external electric field is zero but the induced electric field is taken into account as has been done for the case of a magnetized sphere. The effect of slip is incorporated by assuming that the Knudsen number is small but not negligible, so that the flow lies in the slip flow regime. The magnetic Reynolds number was taken to be small so as to neglect the induced magnetic field, but the analysis can be extended to take an account of it also. The solutions here are for Stokes' type of approximation of neglecting the inertia terms in comparison with the viscous terms. (M.H.R.)

17448 HYDROMAGNETIC FLOW DUE TO AN ACCELERATED PLATE. Pop, Ioan (Babes-Bolyai Univ., Cluj). Rev. Roum. Phys., 12: 865-7(1967).

Gupta (J. Phys. Soc. Japan, 15: 1894 (1960)) has studied the hydromagnetic flow of a viscous incompressible and electrically conducting fluid due to accelerated motion of an infinite flat plate in the presence of a uniform magnetic field fixed relative to the fluid. In this note, the distribution of the velocity is determined by the expansion in series after the hydromagnetic parameter, and it is shown how the distribution of the velocity and the skin friction ratio on the plate vary, with and without the hydromagnetic interactions, in the cases of impulsive motion and uniform accelerated motion, respectively. (auth)

17449 FLUID FLOW THROUGH RECTANGULAR CHANNELS WITH CONDUCTING WALLS IN THE PRESENCE OF ARBITRARILY ORIENTED MAGNETIC FIELDS. Deutsch, R. V.; Ciubotariu, C. (Polytechnic Inst., Jassy, Roumania). Rev. Roum. Phys., 12: 830-46(1967).

Hartmann's problem for an incompressible conducting fluid flowing through a channel with rectangular cross section with two highly conducting walls is studied. After the problem is mathematically solved, general conclusions are drawn that may be extended to cases which are not mathematically dealt with in this paper, i.e., the appearance and direction of the current within the walls with low conductivity, appearance of an electrical field, and form of the current lines. (auth)

17450 THEORETICAL STUDY OF CERTAIN DRAG MOVEMENTS OF A LIQUID OVER PLANE BORDERS IN THE PRESENCE OF A MAGNETIC INDUCTION FIELD. Poirier, Yves (Faculte des Sciences de Luminy, Marseille). Compt. Rend., Ser. A and B, 265: 889-91(Dec. 18, 1967). (In French).

Theoretical results are given on the different drag movements by plane borders of a viscous electroconducting liquid in the presence of a magnetic induction field normal to the border, in the case of a low Reynolds electromagnetic number. (tr-auth)

17451 INFLUENCE OF PROLONGATION OF THE MAGNETIC FIELD ON THE EXTREMITY EFFECTS IN MAGNETOHYDRODYNAMIC SHOCK TUBES. Nguyen-Ngoc-Tran (Centre de Calcul Analogique, Chatillon-sous-Bagneux, France). Compt. Rend., Ser. A and B, 265: 892-4(Dec. 18, 1967). (In French).

The effects of extremities are prejudicial to the efficiency of magnetohydrodynamic shock tubes. The effect of a prolongation of the magnetic field beyond the ends of the electrodes was studied. In the case of a constant prolongation, a calculation method is proposed which makes it possible to calculate, in all approximation orders, N_j, the electric potential φ and the current function of the flow Ψ. (tr-auth)

17452 HEAT TRANSFER ON MAGNETOHYDRODYNAMIC FLOW IN THE ENTRANCE REGION OF A FLAT DUCT. Fan, L. T.; Hwang, C. L.; Knieper, P. J.; Hwang, U. P. (Kansas State Univ., Manhattan). Z. Angew. Math. Phys., 18: 826-44(Nov. 25, 1967).

Temperature profiles and heat transfer parameters were calculated for laminar forced convection heat transfer to an electrically conducting fluid in the entrance region of a flat duct with a transverse magnetic field. Internal heat generation by Joule's electrical dissipation and viscous dissipation are taken into account. Finite difference methods were used to obtain velocity profiles and temperature profiles. Numerical results are presented for Hartmann numbers of 0, 4, and 10 with the viscous criterion factor and the electrical field factor as parameters. (D.L.C.)

17453 ONE-DIMENSIONAL MAGNETOHYDRODYNAMIC FLOW AND THE MONGE-AMPERE EQUATION. Gundersen, Roy M. (Univ. of Wisconsin-Milwaukee, Milwaukee). Z. Angew. Math. Phys., 18: 867-76(Nov. 25, 1967).

The work of Ludford and Martin on one-dimensional flows of an ideal gas is extended to perfectly conducting fluids. A derivation of the fundamental equation is given, and isentropic simple waves are considered. General isentropic flows are considered, and it is shown that the problem is to find solutions of a generalization of the Euler–Poisson equation. The case of oblique magnetic fields is considered, and it is seen that simple waves may be studied exactly as in the transverse field case. (D.L.C.)

17454 COMMENT ON "JET COMPRESSION FOR CLOSED-CYCLE MAGNETOPLASMADYNAMIC ELECTRICAL POWER GENERATION." Angelino, Gianfranco (Centro Nazionale di Ricerca, Milan). J. Spacecraft Rockets, 4: 1564-7(Nov. 1967).

The performance of a jet compressor for closed-cycle magnetoplasmadynamic electrical power generation is calculated and the results of a numerical analysis are given. Comments by the author are answered by Shih. (W.D.M.)

17455 MAGNETOGASDYNAMIC RE-ENTRY PHENOMENA. Nowak, R.; Kranc, S.; Porter, R. W.; Yuen, M. C.; Cambel, Ali Bulent (Northwestern Univ., Evanston, Ill.). J. Spacecraft Rockets, 4: 1538-42(Nov. 1967).

In-flight and laboratory conditions that may be expected in magnetogasdynamic re-entry studies are compared. The phenomenological aspects of the problem are considered from fluid-mechanical and thermodynamic viewpoints. The laboratory apparatus are described and the experimental observations of increases in the bow shock standoff distance and drag are discussed. It is shown that such increases are appreciable even with moderately strong magnetic fields. It is seen that the experimental data agree fairly well with the theory. (auth)

17456 FRIEDRICHS DIAGRAM IN THE CONSIDERATION OF THE HALL EFFECT. Deutsch, R. V.; Fornwald, F. Beitr. Plasmaphys., 7: 249-57(1967). (In German).

The problem of the construction of the Friedrichs diagram has an important significance in the investigation of the flow in thin profiles. The equation of the Friedrichs diagram in random hodographs was given. This equation was applied to the investigation of the diagram of the magnetohydrodynamic waves in the lacking Hall effect. The form of the Friedrichs diagram was investigated with consideration of the Hall current, especially in the slow and Alfvén waves. (tr-auth)

17457 MAGNETODYNAMIC WAVE IN A CYLINDRICAL FLUID MASS. Ignat, Margareta. Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur., 101: 879-99(1966-67). (In Italian).

The propagation of magnetodynamic waves of assigned frequency in a fluid of variable density, finite electric conductivity, with the viscosity coefficients μ and μ' and on which non-electromagnetic natural forces do not act was studied. On the assumption that the fluid fills a cylinder having the generatrices parallel to the "z" axis, the case of an indefinite circular cylinder having an axial symmetry and the case of a finite cylinder of length "l" with random cross section were studied. In the search for the solutions with respect to velocity and to the magnetic field, only the case in which the viscosity coefficients and the electrical resistivity are sufficiently small to be neglected in the equations is considered. (tr-auth)

17458 SLOW FLOW OF A VISCOUS FLUID AROUND A HOLLOW SPHERE IN THE PRESENCE OF A MAGNETIC FIELD. Levy, Therese (Service de Mecanique Theorique, Paris). Compt. Rend., Ser. A and B, 265: 637-40(Nov. 13, 1967). (In French).

The steady flow of a viscous incompressible electrically conducting fluid around a hollow sphere in the presence of a uniform magnetic field at infinity is examined in the case of a negligible Reynolds number. The Hartmann number M is assumed small and the magnetic Reynolds number R_m is small because of M, but not negligible. The R_m order terms in the expressions of the magnetic field and the field velocities are explicitly determined by the method of small perturbations. (tr-auth)

17459 SURFACE TENSION OF THE LIQUID ALKALI METALS MEASURED IN ULTRA-HIGH VACUUM. Germer, D.; Mayer, H. (Technische Hochschule, Clausthal-Zellerfeld, Ger.). Z. Phys., 210: 391-402(1968). (In German).

The surface tension of highly purified, liquid alkali metals and its temperature dependence were measured under ultrahigh-vacuum conditions. The results obtained for sodium agree with those of ADDISON and TAYLOR as well as the theoretical values given by STRATTON and ZADUMKIN, whereas the results on K, Rb, and Cs are different from all values obtained hitherto by others. The temperature dependence of surface tension of all alkalis follows theoretical predictions. There is no observable influence of Ar and O_2 on the surface tension up to 10^{-3} Torr. (auth)

17460 DISCONTINUITIES IN NONIDEAL MAGNETOGASDYNAMICS. Friedel, Helmut (Innsbruck Univ.). J. Math. Phys. (N.Y.), 8: 2234-6(Nov. 1967).

An evolutionary condition is derived from generalized jump relations including dissipation terms and applied to the basic equations of magnetogasdynamics. Two contact discontinuities existing as solutions of these equations are found not to be evolutionary. (auth)

Geophysics

Refer also to abstracts 17198, 17267, and 17346.

17461 (JPRS-44343) BIBLIOGRAPHY OF SOVIET UPPER ATMOSPHERE AND OUTER SPACE STUDIES. Translation of a Russian Report. 48p. CFSTI.

This bibliography was included as part of a report of the Soviet Space Committee to the Tenth Session of COSPAR at London, Dec. 1967, on Soviet space activities. The following areas are included; general papers, flight dynamics, structure and composition of the upper atmosphere, airglow, ionosphere, radio-wave propagation, magnetosphere, solar activity, cosmic rays, meteors and meteorites, lunar studies, planets, and space biology. (W.D.M.)

17462 STRUCTURE OF THE NEUTRAL UPPER ATMOSPHERE. **Izakov, M. N. Space Sci. Rev., 7: 579-641 (Dec. 1967). (In Russian).**

The available experimental data obtained mainly by means of rockets and satellites are summed up. Main attention is devoted to the thermosphere, as the most variable region where variations in structural parameters reach orders of magnitude. The conclusion is drawn that by the present time all the basic variations are detected, although their absolute values should be determined more precisely. This refers primarily to latitude-seasonal variations and especially variations in polar regions. For the main density and temperature variations at heights above 150 to 200 km connected with solar activity, time of the day and geomagnetic disturbances, empirical or semi-empirical dependencies on determining parameters have been found, which allows the determination of the atmospheric structure with sufficient accuracy, at least at low and middle latitudes. Some disagreements in data and their possible reasons are discussed in connection with the accuracies of the various methods. Models of the structure of the upper atmosphere are considered, i.e., systems of interrelated structural parameters satisfying the main physical regularities and describing experimental results, and methods of their construction. (auth)

17463 AURORAL INVESTIGATIONS BY MEANS OF ROCKETS. **Pfister, W. (Air Force Cambridge Research Labs., Bedford, Mass.). Space Sci. Rev., 7: 642-88 (Dec. 1967).**

A survey of rocket experiments undertaken to study auroral zone events includes summary information about instrumentation and results in the field of energetic electrons and protons, charged particle densities, optical observations, magnetic and electric fields, bremsstrahlung x rays, thermal electrons, and production rates. Other auroral investigations except those involving rockets have been largely ignored. (auth)

17464 EMISSION OF PLASMA WAVES BY THE EARTH'S BOW SHOCK. Tidman, D. A.; Northrop, T. G. **(Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 1543-53 (Mar. 1, 1968).**

A general technique is given for calculating the spectrum of plasma waves emitted upstream and downstream by a turbulent shock transition for a plane shock of arbitrary structure. The problem of identifying the waves of frequency ~1 cps that sometimes appear to emanate from the Earth's bow shock is discussed. (auth)

17465 EARLY EFFECTS OF INCREASING SOLAR ACTIVITY UPON THE TEMPERATURE AND DENSITY OF THE 1000-KILOMETER IONOSPHERE. **Brace, L. H.; Mayr, H. G.; Reddy, B. M. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 1607-15 (Mar. 1, 1968).**

Observations of electron temperature and concentration at 1000 km carried out continuously since October 1964 by electrostatic probes on Explorer 22 have permitted certain ionospheric effects of increasing solar activity to be detected. Midday and midnight measurements throughout the lattide range of approximately 60°N to 60°S for one-month periods in January 1965, 1966, and 1967 are presented. Comparison of these latitude profiles shows that the daytime electron concentration at 1000 km increases with solar activity at all latitudes, while the electron temperature increases initially (in the period from 1965 to 1966) but then decreases (1966 to 1967). The nighttime ionosphere is less affected by the increased solar activity, although N_e decreases somewhat, and T_e increases slightly. This behavior of the 1000-km ionosphere can be understood qualitatively in terms of the changing composition and density of the neutral atmosphere, which in turn is caused by the increase in neutral temperature during this period of increased solar activity. A factor of prime importance for the electron temperature is the escape of neutral hydrogen, which reduces the effective local cooling of electrons and permits T_e to rise initially. The higher gas temperatures associated with further increases in solar activity cause enhancement of the heavier neutral constituents (O, He), which again increases the local electron cooling and results in a return to lower electron temperatures. (auth)

17466 ROCKET MEASUREMENTS OF THE E-REGION ELECTRON CONCENTRATION DISTRIBUTION IN THE VICINITY OF THE GEOMAGNETIC EQUATOR. **Aikin, A. C.; Blumle, L. J. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 1617-26 (Mar. 1, 1968).**

Six rocket measurements of the E-region electron concentration distribution were conducted in the vicinity of the geomagnetic equator near the coast of Peru. The instrumentation consisted of the two-frequency propagation experiment and a Langmuir probe. Four of the flights occurred near local noon on separate days. There is little variation between electron concentration profiles. No sporadic E layer was observed, although q-type sporadic E was visible on ionograms taken simultaneously with the flights. The remaining two flights were conducted on separate nights. The electron concentration height profiles suggest that on certain nights or, alternately, after midnight the equatorial E region above 150 km is under F-region control. The existence of a downward drift is supported by the measurements. Below 150 km, the existence of a layer at night has been established. The layer centered at 105 km had a peak density of 2×10^3 cm^{-3} on March 26, 1965, and 1.5×10^4 cm^{-3} on March 18, 1965. It is similar to that formed at midlatitudes. (auth)

17467 FORMATION OF SMALL-SCALE IRREGULARITIES IN THE IONOSPHERE. **Reid, George C. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Geophys. Res., 73: 1627-40 (Mar. 1, 1968).**

This paper examines the relevance to the ionosphere of a certain plasma instability mechanism previously discussed by several authors. A linearized analysis of the mechanism is given that differs from earlier treatments in several respects and is more directly applicable to the ionosphere than to laboratory plasmas. It is found that the dynamo region of the ionosphere is likely to be unstable against the growth of irregularities in electron concentration with scale sizes in the range from a few tens of meters to a few kilometers, given the presence of steady electric fields comparable to those expected to be present from tidal dynamo action. It is further suggested that the space-charge potentials associated with the growth of the dynamo-region irregularities of larger scale size can be conducted up the magnetic field lines into the F region, generating irregularities there in the presence of a vertical gradient in ionization near the equator and in the presence of horizontal gradients at high magnetic latitudes. It is shown that this theory appears to be capable of explaining many of the observed features of F-region irregularities, including their diurnal variation and their correlation with magnetic disturbance, which is in a positive sense at high latitudes and in a negative sense in the vicinity of the dip equator. The relationship of the mechanism to earlier theories of the growth of small-scale F-region irregularities is discussed. (auth)

17468 SOLAR CYCLE VARIATION OF BLANKETING SPORADIC E. **Reddy, C. A.; Matsushita, S. (High Altitude Observatory, Boulder, Colo.). J. Geophys. Res., 73: 1641-60 (Mar. 1, 1968).**

The hourly values of the blanketing frequency of midlatitude sporadic E (fbEs), obtained at six stations over the eight-year period of 1958–1965, were analyzed to study the solar cycle variations in the monthly mean values of fbEs and in the percentage occurrences of fbEs exceeding each of the six limiting frequencies: 0.5, 2.0, 3.0, 4.0, 5.0, and 6.0 Mc. The results of the analysis show that (1) the monthly mean values of fbEs as well as the occurrences of fbEs ≥ 4.0 Mc have marked positive correlation with the sunspot number at all the six stations, but (2) the occurrences of smaller fbEs values (-4.0 Mc) increase markedly with decreasing sunspot activity. In addition, strong seasonal variations both in fbEs and in Es occurrence are observed. Calculations based on the equations of wind shear theory indicate that the seasonal as well as the solar variations in fbEs are caused predominantly by corresponding variations in the E-region wind shears. Further, it is shown that both the positive correlation of the occurrence frequencies of larger fbEs values (≥4.0 Mc) and the negative correlation of the occurrence frequencies of smaller fbEs values (<4.0 Mc) with sunspot activity are consistent with the theoretically expected behavior. (auth)

17469 ELECTRON CONCENTRATIONS AND ELECTRON AND ION TEMPERATURES IN THE F REGION FOR MAGNETICALLY QUIET AND DISTURBED CONDITIONS. **Rao, P. B. (Cornell Univ., Arecibo, Puerto Rico). J. Geophys. Res., 73: 1661-78 (Mar. 1, 1968).**

Incoherent backscatter measurements of the F-region electron concentrations and electron and ion temperatures were made at Arecibo during the sudden commencement magnetic storm of June 15–16, 1965, and a few magnetically quiet days in the same season. The results obtained are used to describe the quiet and disturbed day diurnal behavior of the shape of the electron concentration profile, the contours of constant plasma frequency, the plasma density scale heights in the topside ionosphere, and the electron and ion temperatures. Storm-day deviations of some of the important F-region parameters were also calculated, and their temporal variations are presented. In response to the strong magnetic storm, the electron concentrations in the topside ionosphere are enhanced by a factor of 1.5 to 2.0 and the nighttime plasma density scale heights by a factor of 2.0 to 3.0. The electron temperatures under disturbed conditions are 200 to 300°K higher than the quiet day values during nighttime, whereas the daytime changes are within the limits of day to day variations. The changes in the ion temperatures, which are found to be appreciable during the daytime, suggest that under disturbed conditions the ion temperature is coupled to the neutral temperature to a greater height level than during quiet conditions. A significant amount of storm-associated heating of the nighttime F region is evident from the electron-to-ion temperature ratios that are found to be above 1.5 throughout the night in the height range 225 to 450 km. (auth)

17470 MUTUAL EFFECT OF PRECIPITATED AURORAL ELECTRONS AND THE AURORAL ELECTROJET. **Maehlum, Bernt N.; O'Brien, Brian J. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 1679-84(Mar. 1, 1968).**

It has been found that the perturbation in the geomagnetic field produced by the auroral electrojet also perturbs the pitch-angle distribution of the precipitated electrons that are the dominant contributors to the auroral ionization within which it is assumed the auroral electrojet flows. To study this interaction in detail, a computer program has been developed for model calculations. This program computes: (1) the electron concentration profile in the ionosphere from a given pitch-angle and energy distribution of the ionizing electrons, and (2) the changes in the pitch-angle distribution created by the geomagnetic field deformations caused by the auroral electrojet current system itself. Results from preliminary computations are discussed. It is shown that the interaction can cause significant time variations in an initially time-stationary electron precipitation event. Thus, for the first time it is seen that naturally occurring atmospheric 'feed-back' effects can account for some of the dynamic auroral variations without requiring the auroral source itself to vary in time. The variations are governed by the pitch-angle distribution and the total flux of precipitated electrons, as well as by the normal loss parameters in the upper atmosphere. For medium-to-strong electron precipitation events, the calculated periodicity of the variations lies in the range 50 to 200 seconds, which is in agreement with some of the direct observations of auroral electron periodicities. (auth)

17471 STUDIES OF THE MAGNETOSPHERIC SUBSTORM. I. CHARACTERISTICS OF MODULATED ENERGETIC ELECTRON PRECIPITATION OCCURRING DURING AURORAL SUBSTORMS. **Parks, G. K.; Coroniti, F. V.; McPherron, R. L.; Anderson, K. A. (Univ. of California, Berkeley). J. Geophys. Res., 73: 1685-96 (Mar. 1, 1968).**

The temporal, energy, and spatial characteristics of energetic auroral-zone electron precipitation in the 5- to 35-sec period range are discussed. The electron pulsations of 5- to 10-sec period occur during 0200–1000 local time, have a soft energy spectrum with an e-folding energy of about 15 keV, and show spectrum hardening at the peaks. The region over which the electron pulsations are occurring is about 100 to 150 km. The electron pulsations of 20- to 35-sec period occur during 1000–1500 local time, possess a hard energy spectrum with an e-folding energy of about 30 keV, and occasionally show spectral hardening at the peaks. The scale size of these electron pulsations is often 100 to 150 km, but occasionally it is greater than 210 km. The electron pulsations and the other forms of energetic electron precipitation that occur in the auroral zone are direct consequences of worldwide disturbance characteristics of auroral substorms. (auth)

17472 STUDIES OF THE MAGNETOSPHERIC SUBSTORM. II. CORRELATED MAGNETIC MICROPULSATIONS AND ELECTRON PRECIPITATION OCCURRING DURING AURORAL SUBSTORMS. **McPherron, R. L.; Parks, G. K.; Coroniti, F. V.; Ward, S. H. (Univ. of California, Berkeley). J. Geophys. Res., 73: 1697-1713(Mar. 1, 1968).**

The temporal characteristics of geomagnetic micropulsations and the associated energetic auroral-zone electron precipitation are presented as a function of local time. In the midnight region, broadband noise bursts and impulsive electron precipitation are related to the auroral breakup. Band-limited irregular (Pi 1) micropulsations and modulated electron precipitation of 5- to 10-sec period occur from 0200 to 1000 in conjunction with negative bays. In the local-time interval 1000–1500, quasi-sinusoidal (Pc 3) micropulsations are related to modulated electron precipation of 20- to 40-sec period. Power spectrum and digital sonagram analysis for the band-limited irregular and quasi-sinusoidal micropulsations and the modulated electron precipitation are presented. Around local noon, magnetic impulses are correlated with electron microbursts. From 1500 to 2200, sweepers or IDPD events and premidnight micropulsations show no relationship to electron precipitation, but they are closely related to auroral substorms. Pearl pulsations appear to have no definite association with either electron precipitation or substorms. (auth)

17473 STUDIES OF THE MAGNETOSPHERIC SUBSTORM. III. CONCEPT OF THE MAGNETOSPHERIC SUBSTORM AND ITS RELATION TO ELECTRON PRECIPITATION AND MICROPULSATIONS. **Coroniti, F. V.; McPherron, R. L.; Parks, G. K. (Univ. of California, Berkeley). J. Geophys. Res., 73: 1715-22(Mar. 1, 1968).**

The concept of the auroral substorm is reviewed in terms of recent satellite measurements of the magnetospheric effects of a substorm, and a more general and inclusive terminology, the magnetospheric substorm, is suggested. In support of this suggestion, it is shown that the various forms of geomagnetic micropulsations and energetic electron precipitation that have been discussed in papers 1 and 2 occur at their respective local times during a substorm. Balloon x-ray and micropulsation data obtained by the Berkeley group, as well as rheometer absorption, Earth currents, and standard magnetograms from several auroral-zone stations, were used. (auth)

17474 DETECTION OF ELECTROMAGNETIC AND ELECTROSTATIC WAVES ON OV3-3. **Scarf, F. L.; Fredricks, R. W.; Crook, G. M. (Space Sciences Lab., Redondo Beach, Calif.). J. Geophys. Res., 73: 1723-45(Mar. 1, 1968).**

The TRW Systems electric field experiment on OV3-3 (1966-70A) has one broadband channel and four bandpass channels covering the frequency range 20 Hz to 7.35 kHz, plus an onboard E, B correlator, which operates at a frequency of 400 Hz. The E-field sensor is a short boom-mounted asymmetric dipole that detects electric oscillations in the spacecraft equatorial plane. Examination of the angular distributions, and the loop and correlator response, allows electrostatic and electromagnetic waves to be distinguished. Details of the method of operation of the electric field sensor and related instrumentation are given, and preliminary results from the bandpass channels are displayed and discussed. (auth)

17475 ION CYCLOTRON WHISTLERS IN THE SOLAR WIND. **Scarf, F. L.; Fredricks, R. W. (Space Sciences Lab., Redondo Beach, Calif.). J. Geophys. Res., 73: 1747-55(Mar. 1, 1968).**

The wave characteristics and the growth and damping rates for low-frequency electromagnetic modes in a multicomponent solar wind were investigated. It is shown that the instability associated with the observed thermal anisotropy for protons is strongly modified when a finite percentage of alpha particles is present. The helium component can directly absorb electron whistler mode wave energy generated via the field-aligned proton anisotropy. Furthermore, in the multicomponent plasma, mode coupling occurs, so that the electron whistler mode signals trigger proton whistlers. These waves are in turn strongly damped by a conventional resonant interaction with the protons. (auth)

17476 VECTOR MEASUREMENT OF THE MIDLATITUDE Sq IONOSPHERIC CURRENT SYSTEM. **Cloutier, P. A.; Haymes, R. C. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 1771-87(Mar. 1, 1968).**

This paper reports the results of two flights of vector magnetometer systems designed to measure the magnitude and direction of the ionospheric current system responsible for the solar quiet daily geomagnetic variation. The measurements were obtained from cesium vapor magnetometers with bias coils flown aboard sounding rockets from Wallops Island, Virginia. Instrumental difficulties on both flights limited the resolution of measurement, but the data indicated that current sheets were penetrated on both flights. These current sheets were observed to be thinner and more intense than those measured by previous investigators, and were confined to the lower edge of the altitude range over which currents have usually been observed. The unusual altitude profiles on both flights and an anomalously large current magnitude with a fluctuating direction observed on the second flight are attributed to localized enhancement of ionospheric electron concentration in sporadic E layers observed in ionograms taken during the flights. Because of disturbed ionospheric conditions and unknown boundary effects due to horizontal localization of the sporadic E layer, it is difficult to evaluate the validity of theoretical conductivity models. However, calculations of the conductivity profile required by the current position and intensity indicate that the observed current structure requires electron concentration enhancement compatible with that experimentally observed in sporadic E layers. Previous theoretical work also predicts a localized enhancement of the Sq current confined to the horizontal extent of the sporadic E layer, although such a large enhancement as was observed is not easily explainable. (auth)

17477 QUIET-DAY ELECTROJET OVER THUMBA, INDIA. **Sastry, T. S. G. (Physical Research Lab., Ahmedabad, India). J. Geophys. Res., 73: 1789-94(Mar. 1, 1968).**

A Nike–Apache payload containing a proton precession magnetometer and a Langmuir probe was launched on July 7, 1966, at 1345 hours IST. The day was magnetically very quiet. A large change in field of 75 ± 2 γ due to the electrojet was observed between 90- and 118-km altitude. Vertical profile of magnetic field distribution through the electrojet obtained from rocket measurements was found to follow closely the distribution calculated by Sugiura and Cain for a model electrojet over Thumba, India (80°E). The strengths of the electrojet determined from rocket and ground magnetometer measurements agree well with each other under certain assumptions. Comparison of present results with the results of magnetometer flights UNH 64-1 and UNH 64-2 conducted at Thumba in 1964 shows that the nature of the electrojet has changed considerably during the periods 1964 and 1966. The results also indicate the possibility of existence of two weak subsidiary current layers above the strong electrojet region, the lower one centered around 132 km and the higher at 162 km. (auth)

17478 GEOMAGNETIC D_p2 FLUCTUATIONS AND ASSOCIATED MAGNETOSPHERIC PHENOMENA. Nishida, Atsuhiro (Tokyo Univ.). J. Geophys. Res., 73: 1795-1803(Mar. 1, 1968).

A D_p2 fluctuation has a time scale of about one hour and appears coherently all over the world. It differs from the polar substorm (D_p1) in that it is not caused by the activation of the auroral electrojet. Its current system consists of twin current vortices and a zonal part. It is associated with fluctuations in the magnetospheric plasma convection, and it will provide a useful means for the identification of the 'viscous-like' interaction mechanism. (auth)

17479 CHARACTERISTICS OF Pg MICROPULSATIONS AT CONJUGATE POINTS. **Annexstad, John O.; Wilson, Charles R. (Univ. of Alaska, College). J. Geophys. Res., 73: 1805-18 (Mar. 1, 1968).**

The Pg micropulsation is a unique 100-second sinusoidal oscillation that appears infrequently and only on the records of stations located near the auroral zone. Twenty such events were observed during 1963 and 1964 at the approximately conjugate observatories of College, Alaska, and Macquarie Island. Vector diagrams of the perturbation vector, power spectral density analysis of the events, and dispersion measurements of the wave form were used in this analysis. The characteristics of the Pg, as determined by these methods, are used to show that this type of micropulsation is produced by transverse hydromagnetic waves propagating along field lines to small, high-altitude, conjugate areas. (auth)

17480 SPATIAL DIFFUSION OF SMALL PARTICLES IN AN EXPONENTIAL ATMOSPHERE. **Klein, M. M. (GCA Corp., Bedford, Mass.); Yu, K. J. Geophys. Res., 73: 1829-35(Mar. 1, 1968).**

Calculations were made of the spatial diffusion of small particles, released initially in the form of a point source, in an exponential atmosphere, and the results are presented in the form of relative density curves and absolute density contours. It is noted that the decrease along the horizontal direction of the relative density occurs most rapidly for the heavy particles, regardless of the altitude. The absolute density of a heavy particle may exceed that for a light one, but only in a narrower region near the position of maximum density, indicating the small dispersal of the heavy particles. The calculations are limited to the case of a point source release, but they may be extended in a direct manner to include an arbitrary initial distribution. (auth)

17481 POSSIBLE CONSEQUENCES OF AKASOFU'S NEUTRAL HYDROGEN HYPOTHESIS. **Swift, Daniel W. (Univ. of Alaska, College). J. Geophys. Res., 73: 1847-50(Mar. 1, 1968).**

It is pointed out that Akasofu's neutral hydrogen mechanism for the formation of the ring current belt should lead to an electrostatic instability that should be readily detectable with present-day satellites. The detection of signals with characteristics specified in this paper would add considerable support to Akasofu's hypothesis. On the other hand, if no such signals are detected, then the mechanism can be all but eliminated as a reasonable explanation for the formation of the ring current belt. The consistency of Akasofu's hypothesis with Frank's (1967) measurements of ring current particles is also discussed. (W.D.M.)

17482 ON THE COMPARISON OF TEMPERATURE JUMPS ACROSS THE EARTH'S SHOCK: VELA 3 SATELLITE AND GAS-DYNAMIC THEORY. **Spreiter, John R.; Summers, Audrey L.; Alksne, Alberta Y. (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res., 73: 1851-2(Mar. 1, 1968).**

Recently, Argo et al. (1967), showed that the ratio of the velocities and densities on the two sides of the Earth's bow shock, measured by two Vela 3 satellites on 13 shock crossings, are in close agreement with the theoretical predictions provided by the gas dynamic calculations of Spreiter et al. (1966), but that the ratio of the temperatures is twice the calculated value. It is shown that most of this discrepancy may be attributed to the arbitrary selection of a nominal value of 8 for the free-stream Mach number of the solar wind, and that calculations based on the actual Mach number calculated from the measured speed and temperature of the solar wind, in accordance with the usual expression, are in substantial agreement with the Vela 3 observations. (W.D.M.)

17483 POSSIBLE RELATIONSHIP BETWEEN THE STORM-TIME WHISTLER CUTOFF AND THE MAGNETOSPHERIC RING CURRENT. **Bauer, S. J.; Krishnamurthy, B. V. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 1853-7 (Mar. 1, 1968).**

It is suggested that the whistler cutoff, i.e., the absence of whistlers beyond certain L shells or in certain L-shell intervals, as observed during magnetic storms, may be caused by the high-energy-density magnetospheric ring-current plasma (specifically the electron component). Arguments for this contention are presented. (W.D.M.)

17484 ANTIPODAL EFFECT DUE TO MAGNETOHYDRODYNAMIC WAVE PROPAGATION AFTER THE STARFISH DETONATION OF JULY 9, 1962. **Murphy, Brian L.; Kahalas, Sheldon L. (Mt. Auburn Research Associates, Inc., Cambridge, Mass.). J. Geophys. Res., 73: 1858-60(Mar. 1, 1968).**

Bomke et al. (1966), have constructed global contours of equal field intensity for the magnetic disturbance recorded by standard magnetometers after the Starfish detonation. The purpose of this letter is to point out that the Indian Ocean high may be explained in terms of magnetohydrodynamic wave propagation phenomena. The proposed explanation assumes that the unguided field alone is responsible for the maximum of magnetic intensity occurring over the Indian Ocean. (W.D.M.)

17485 GENERALIZATION OF ABEL'S SOLUTION FOR BOTH MAGNETOIONIC COMPONENTS IN THE REAL-HEIGHT PROBLEM. **Paul, Adolf K.; Smith, G. H. (Inst. for Telecommunications Sciences and Aeronomy, Boulder, Colo.). Radio Sci., 3: 163-70(Feb. 1968).**

Modern methods of calculating the electron density distribution from virtual heights include joint use of both magnetoionic components since, in certain ranges, one component alone does not provide sufficient information to obtain a unique solution of the integral equation involved. Experience shows, however, that joint use of both components does not always give satisfactory results. Therefore, a solution formula is first developed for each component, in a form similar to the Abel solution valid for an isotropic ionosphere. Application of these generalized solution formulas to each component and a combination of the two resulting expressions leads to a new integral equation in which only the distribution of the underlying ionization or the distribution in the valley between two layers is involved. Consideration of this new integral equation leads to the result that, in general, only a first- or second-order approximation to the distribution in those parts can be obtained. (auth)

17486 IONOSPHERIC DIAGNOSTICS USING RESONANCES OF AN ELECTRIC DIPOLE IMPEDANCE. **Blair, W. E. (Stanford Research Inst., Menlo Park, Calif.). Radio Sci., 3: 155-61(Feb. 1968).**

A technique of using the driving-point impedance of an electric antenna in the ionosphere to diagnose the ionospheric plasma is presented. Specifically, the locations of the resonances in the driving-point impedance of a center-fed cylindrical electric dipole imbedded in the ionosphere are analyzed. The ionospheric model is a lossy, anisotropic, homogeneous neutral plasma containing various ionic constituents. It is found that there are zeros in the reactance at the upper and lower hybrid frequencies and poles at the electron and ion gyrofrequencies. These critical frequencies are independent of antenna length and orientation (parallel or perpendicular to the earth's magnetic field) to the first-order approximation. It is shown that pole-zero frequencies could be used to determine the earth's magnetic field strength, electron density, and ion masses and densities at any point in the ionosphere at which the impedance was measured. Consequently, this technique offers the possibility of measuring several ionospheric plasma characteristics with one instrument aboard rockets and satellites. (auth)

17487 THE SHEFFIELD UNIVERSITY VLF EXPERIMENT ON THE SATELLITE ARIEL 3. Bullough, K. (Univ. of Sheffield, Eng.); Hughes, A. R. W.; Hudson, T.; Hickinson, D.; Broomhead, P.; Tomlinson, P. J. Phys., E, 1: 77-85(Feb. 1968).

One of the five experiments carried by the spacecraft was concerned with a synoptic study of vlf phenomena above the ionosphere using a vlf receiver with loop aerial. The peak, mean, and minimum signals at 3.2, 9.6, and 16 kHz were measured in each 28 second period around the orbit. At 16 kHz wide (Δf = 1 kHz) and narrow (Δf = 100 Hz) band channels were used to distinguish cw transmissions from GBR (Rugby) from natural noise-like signals such as hiss. The measurements were stored on the satellite tape recorder and telemetered to ground at an appropriate Stadan station. The factors governing the choice of receiver parameters are discussed. The equipment and technical problems encountered are described. (auth) (UK)

17488 VLF OBSERVATIONS ON ARIEL III: A PRELIMINARY REPORT. Bullough, K.; Hughes, A. R. W.; Kaiser, T. R. (Univ. of Sheffield, Eng.). Radio Electron. Eng., 35: 103-8(Feb. 1968).

The very-low-frequency receiver carried by Ariel III makes synoptic studies at 3.2, 9.6, and 16 kHz of the worldwide distribution and occurrence of natural vlf phenomena such as whistlers, chorus, and hiss and also determines the configuration of the wave-field above the ionosphere due to the GBR (Rugby) transmission at 16 kHz. At these three frequencies the peak, mean, and minimum signals are measured in each 28 second period (~2°) around the orbit. The findings reported in this paper are based on a preliminary analysis of 36 orbits (quick-look data). Zones of emission, mainly hiss, are present on every orbit. They occur at both high and medium latitudes, and may often extend over 20° in invariant latitude and down to within 20° of the geomagnetic equator. Whistlers, at medium latitudes, are usually easily identified by the large peak, very low mean and zero minimum signal levels. The signal amplitudes often vary rather smoothly along the orbit, and the pattern of signal amplitude may be repeated on different orbits following the same sub-satellite path. The geomagnetic field and the D region are the main factors determining the configuration and intensity of the GBR (Rugby) 16 kHz wave-field above the ionosphere. Signals were identified at locations as remote as the Antipodes and the North Pacific. (auth) (UK)

17489 VARIATIONS IN AIR DENSITY AT HEIGHTS NEAR 150 km, FROM THE ORBIT OF THE SATELLITE 1966-101G. King-Hele, D. G.; Hingston, Janice (Royal Aircraft Establishment, Farnborough, Eng.). Planet. Space Sci., 15: 1883-93(Dec. 1967).

The satellite 1966-101G was launched on November 2, 1966, into an orbit with an initial perigee height of 140 km. A satellite with such a low perigee usually decays within a few days, but 1966-101G remained in orbit until May 6, 1967. Analysis of the changes in its orbital period provided a unique opportunity for studying continuously for six months the variations in air density at a height near 150 km. The results of such an analysis are given, applicable for the (medium) level of solar activity prevailing early in 1967. It is shown that at a height of 155 km the air density is greater by day than by night, with the maximum daytime density exceeding the minimum night-time density by a factor of 1.7. In contrast the COSPAR International Reference Atmosphere 1965 predicts that the density should be slightly greater by night than by day. It is also found that the night-time density increases as solar activity increases, and that the density scale height given by CIRA 1965 at heights near 150 km is too low, perhaps by about 20%. (auth) (UK)

17490 A ROCKET-BORNE PHOTOMETRIC INVESTIGATION OF THE OXYGEN LINES AT 5577 A AND 6300 A, THE SODIUM D LINES AND THE CONTINUUM AT 5300 A IN THE NIGHT AIRGLOW. Greer, R. G. H.; Best, G. T. (Queen's Univ. of Belfast). Planet. Space Sci., 15: 1857-81(Dec. 1967).

The relative variations between 82 km and 205 km in the emission rates of nightglow radiation features at 5300, 5577, 5893, and 6300 Å were photometrically measured from a Skylark rocket flown from Woomera, S. Australia, at 2053 hours CST (1123 hours GMT) on October 18, 1965. Emission profiles obtained for the first three features show that these layers have their center of intensity at, respectively, 94.0 ± 1, 94.5 ± 0.5, and 98.0 ± 2 km. The results further indicate that not more than 10% of the 6300 Å radiation was emitted below apogee at 205 km. By virtue of a rather complicated vehicle motion—almost a slow tumble in the vertical plane—evidence is adduced which suggests that differences between these profiles and those of previous flights could be explained by insufficient or incorrect account being then taken of the contamination from extra-atmospheric sources such as starlight and galactic light. Regarding the continuum, it is found that, depending on the particular region of sky background, up to 80% of the 5300 Å emission observed from the Earth may be extra-atmospheric in origin. Furthermore, of the extra-atmospheric component, again depending on the viewing direction in the sky, the emission intensity at 5577 Å may be from 10 to 50% greater than that at 5300 Å. While it is to be expected that, before penetrating the layer, the zenithal emission intensity as registered by the photometers should remain constant, this constancy was not generally observed, and the 5300 and 5577 Å photometers, both of which were independently duplicated, indicated an initial increasing emission intensity. Marked differences in the variation of each pair of photometers suggest that interpretation by means of aerosol absorption of the radiation in the 80- to 100-km region is incorrect, and that the effect is probably instrumental in origin and of a temporary nature. (auth) (UK)

17491 EXPERIMENTS ON THE INTERACTION OF A MOVING PLASMA WITH A DIPOLE MAGNETIC FIELD. Roberts, J. B. G.; Turner, J. P. (Royal Radar Establishment, Malvern, Eng.). Planet. Space Sci., 15: 1847-56(Dec. 1967).

Laboratory experiments on steady and pulsed interactions between moving plasmas and dipole magnetic fields are described. Observations of phenomena resembling those which occur in a typical geomagnetic storm lend support to a description of the storm developed from the theory of Chapman and Ferraro, rather than from the models of the magnetosphere proposed by Alfvén and Karlson. (auth) (UK)

17492 THE CORPUSCULAR HEATING EFFECT OBSERVED BY EXPLORER 6 NEAR SUNSPOT MAXIMUM. Moe, Kenneth (Univ. of California, Los Angeles). Planet. Space Sci., 15: 1821-7(Dec. 1967).

Atmospheric densities derived from the spin decay of Explorer 6 are used to study the corpuscular heating effect at low and middle latitudes near the time of sunspot maximum. The dependence of atmospheric temperature on a_p (3-hourly geomagnetic planetary amplitude) is found to be quite similar to the recently revised curve of Jacchia et al. (Smithsonian Astrophys. Obs. Spec. Rept. No. 170 (1964)), which applies to later times in the sunspot cycle, but also at low and middle latitudes. Both curves are very different from those found from polar satellites in orbits of low eccentricity. Averaging a_p over half a day instead of delaying it by a quarter day improves the fit of the models to the data. (auth) (UK)

17493 RESONANCE SCATTERING BY N_2^+. Broadfoot, A. Lyle (Kitt Peak National Observatory, Tucson, Arizona). Planet. Space Sci., 15: 1801-15(Dec. 1967).

A study is made of the intensity distribution among the bands of the Meinel and first negative system of N_2^+ due to resonance scattering of sunlight. Absolute transition probabilities are used to calculate the relative populations among the ion states under resonance scattering conditions; the mean lifetime for deactivation is the parameter which determines the amount of resonance scattering. Photon scattering rates are calculated for most of the ion bands and it is suggested that an appropriate value for the 3914 Å band would be 0.050 photons/sec per ion. Observations of the $\Delta v = -1$ sequence of the first negative system in the twilight spectrum are reported. Extended vibrational development is detected, which indicates that only about 80% of the emission is resonance scattered. Sunlit auroral spectra of N_2^+, however, which have generally been considered to be due predominantly to resonance scattering, indicate that only about 40% of the emission is due to resonance scattering. Measurable effects resulting from a charge-transfer ion source ($O^+(^2D)$) are predicted. (auth) (UK)

17494 RADIATION BELTS IN THE REGION OF THE SOUTH-ATLANTIC MAGNETIC ANOMALY. Vernov, S. N.; Gorchakov, E. V.; Shavrin, P. I.; Sharvina, K. N. (Moscow State Univ.). Space Sci. Rev., 7: 490-533(Nov. 1967).

The present review examines in sufficient detail the prerequisites for the existence of the anomalies in the radiation distribution near the earth, as well as the main experimental works devoted to the study of the radiation in the anomaly region. Data are also given on the particles precipitating from the belts. Topics discussed include charged particle movement in the geomagnetic field, discovery of the radiation belts in the region of the South-

Atlantic anomaly, energy and spatial distribution of the radiation in the region of the anomaly, effect of east–west asymmetry of the proton intensity, time variations of the proton intensity, behavior of belt electrons in the anomaly region. (W.D.M.)

17495 EFFECT OF SOLAR ACTIVITY ON THE PROBABILITY OF THE OCCURRENCE OF THE E_s LAYER AT ITS LIMITING FREQUENCIES IN MIDDLE LATITUDES. Samardzhiev, Dimit'r. Izv. Geofiz. Inst., Bulg. Akad. Nauk, 10: 59-73(1967). (In Bulgarian).

A study was made of the relation between solar activity and occurrence of the sporadic E_s layer at its characteristic limiting frequencies, based on observations from 1957 through 1964 at Dourbes, Juliusruh, and Moscow. More frequent occurrences of the sporadic layer and less frequent occurrences of the layer at ≥3 and ≥5 MHz are established for lower solar activity levels. The median values of the limiting frequencies are suggested as suitable characteristics of the relation between solar activity and the behavior of the sporadic layer. (IAA)

17496 WINTER ANOMALY IN THE IONOSPHERIC E LAYER. Serafimov, Kiril (Geophysical Inst., Sofia); Samardzhiev, Dimit'r. Izv. Geofiz. Inst., Bulg. Akad. Nauk, 10: 43-58(1967). (In Bulgarian).

A review is given of available observational and analytical results concerning the anomalous winter behavior of the ionospheric E layer, pointing out the inaccuracies involved. A revised ionization–equilibrium equation is set up to obtain a criterion for the presence of a winter anomaly in the E layer. The equation incorporates the aeronomic parameters σ, H_0, and α and reflects solar activity-dependent seasonal variations in the critical frequencies of the layer. Latitudinal zones are defined for anomaly observations under optimal quasi-stationary ionospheric conditions. Possible errors of previous results are assessed by an analysis of data of two middle-latitude ionospheric stations taken from 1957 through 1964. Among the causes of errors indicated are the omission of certain theoretical corrections and the dynamics of the diurnal asymmetry of the critical frequencies of the E layer. An analysis of observations at a group of 48 stations across the globe indicates that this "winter anomaly" vanishes at a major portion of these stations when observational results are corrected properly. (IAA)

17497 METHOD FOR DETERMINATION OF THE ELECTRON DENSITIES FROM DATA OF THE RESONANCE PROBE. Dote, Toshihiko; Ichimiya, Torao. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 3: 48-60(Jan. 1967). (In Japanese).

A concrete method is proposed to determine electron density from measurements obtained by a resonance probe, based on a performance mechanism which had recently been used to consider an equivalent electrical circuit of a plasma sheath and probe system. Several diagrams for the calculation of the case of the ionospheric plasma are presented. The method is applied to actual data obtained by the L-3-3 and K-9M-9 ionospheric resonance sounding probes. (IAA)

17498 SCALING CONSIDERATIONS FOR MAGNETOSPHERIC MODEL EXPERIMENTS. Block, Lars P. (Royal Inst. of Tech., Stockholm. Aktiebolaget Atomenergi, Stockholm). Planet. Space Sci., 15: 1479-87(1967).

The scaling problems for plasma gun–terrella experiments on the interaction between the solar wind and the magnetosphere are considered. Good scaling requires a magnetized, collision-free, supersonic, and super-Alfvénic plasma wind. The gyro-radii should be small compared with the size of the magnetosphere both in the plasma wind and at the magnetopause. The Debye length should be small. The mean free paths should be long to produce collision-free conditions. The magnetosphere must be much larger than the terrella. It is found that a simulation of the entire magnetosphere and the collisionless shock requires plasma temperatures in excess of 10^7°K and terrella fields of the order of 10^6 G. The transition region and the outer parts of the magnetosphere beyond about 3 R_e may, however, be simulated by a plasma gun and a terrella with a finite surface conductivity. The collisionless shock may be simulated by a theta-pinch, and the inner part of the magnetosphere by a PIG discharge with high mirror ratios. (auth) (UK)

17499 ABNORMAL INCREASE IN IONOSPHERIC ELECTRON CONTENT. Jones, K. L. Planet. Space Sci., 15: 1603-5(Oct. 1967).

An abnormal ionospheric condition was observed on May 5, 1965, by electron content observation, using the Faraday rotation method. The author has searched for further data which may explain this condition. (UK)

17500 VARIATION IN WIDTH OF THE H_α LINE IN AURORA. Harang, O.; Pettersen, H. Planet. Space Sci., 15: 1599-1603(Oct. 1967).

Observations of the H_α line where the half-width gradually decreased from about 18 Å to less than 5 Å in 1 hr, are reported, indicating relatively intense showers of low energy protons and continuous variation in the energy spectrum. (UK)

17501 RADIANT INTENSITY OF CLEAR AND CLOUDED NIGHT SKY IN THE WAVELENGTH RANGE 0.5 TO 1.1 μM. Hoehn, D. H.; Maffeo, G. F. (Univ., Tuebingen, Ger.). Infrared Phys., 7: 221-45(Dec. 1967). (In German).

Absolute radiant intensities ($\lambda\lambda$ 0.5 to 1.1 μm) of the moonless night sky under various meteorological conditions were investigated with the help of a spectrometer built and calibrated for this purpose ($\Delta\lambda = 0.01$ μm at $\lambda = 0.5$ μm, increasing to $\Delta\lambda = 0.1$ μm at $\lambda = 1.1$ μm). Fluctuating airglow emission lines in the visible region were always found to exist on top of a continuum which steadily increases in intensity to 1.1 μm, and which consists primarily of unresolved OH bands in the near ir. The absolute intensities were found to change considerably with the amount and type of cloud cover, but the spectral form (neglecting the lines) remained consistent, showing, however, a definite tendency to flatten for increasing cloud cover. The dependence of radiant intensities at 0.5577, 0.8, and 1.0 μm on meteorological conditions was statistically examined, resulting in histograms relating frequency of occurrence with radiance. These demonstrate quantitatively the displacement towards lower intensities for increasing cloudiness, this being by about a factor of 3 at 1.0 μm for clear/100% cloudy. The spectral radiances found for clear skies agree well with those found by other authors. (auth) (UK)

17502 OBSERVATIONS OF THE DISTURBED REGION AROUND AN IONOSPHERIC SPACECRAFT. Henderson, C. L.; Samir, U. (Univ. College, London). Planet. Space Sci., 15: 1499-1513(Oct. 1967).

Observations from a Langmuir-type electron probe mounted on a boom about 1.2 m long on the Ariel I satellite were used to study the angular distribution of electron density. A method which analyses the "plateau level" of a (di/dV) characteristic was applied, yielding information on the amount of depletion of electron density in the wake, and the wake extent. It was found that the minimum value of N_e with respect to ambient is about 0.5 ± 0.1. The wakes of both the main body of the satellite and a smaller sphere biased –6V with respect to the satellite were studied. This provides a comparison between the wakes of two bodies having different potentials, different linear dimensions, and at different distances from their surfaces. The wake structures of both the main body and the smaller sphere were similar. This indicates the extent of the influence of the potential of the smaller sphere on electrons, or, in other words, the increase in the effective area presented to the plasma flux by the sphere. Evidence is given for a slight enhancement in the central regions of both wakes. The minimum level of N_e in the wake increases by a factor of 50 over a distance of $4R_0$ downstream from the surface of the main body. Considering the smaller sphere in its role as an ion probe, comment is made on the penetration of the potential field beyond the sheath edge into the plasma. Results are compared with other studies. (auth) (UK)

17503 HYDROXYL ROTATIONAL TEMPERATURES AND INTENSITIES IN THE NIGHTGLOW. Kvifte, G. J. (Auroral Observatory, Tromsoe, Norway). Planet. Space Sci., 15: 1515-23(Oct. 1967).

Spectra of several bands of the OH nightglow emission were obtained at Tromsø and Ås during the autumn of 1963 and spring of 1964, respectively. Rotational temperatures were derived, giving an average of 210 ± 10°K at both stations. No seasonal dependence or latitude effect was found. OH temperatures obtained by earlier investigators are discussed and found to agree mutually and with those reported in the present studies, assuming the OH emission height near 100 km and the atmospheric temperature at this height to vary with solar activity. Absolute band intensities were computed, giving mean values in agreement with earlier investigations. At both stations the observations appear to indicate a seasonal variation of the intensity, showing a minimum during winter. Any latitude effect should be small, possibly giving less intense OH bands north of 60°N. (auth) (UK)

17504 STORMER THEORY AND EULER POTENTIALS. Stern, David (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci., 15: 1525-30(Oct. 1967).

A recently published calculation is examined (Rajappa, Venkatarangan and Viswanathan (Planet Space Sci. Vol. 15, p. 495(1967)), in which the motion of a charged particle in a deformed magnetosphere is treated by an extension of Störmer's method. It is shown that equivalent results may be obtained by replacing the Earth's field with a suitable axisymmetric field derived from first-order geomagnetic Euler potentials, and that the results numerically evaluated and tabulated have a simple interpretation in terms of the guiding-center approximation. (auth) (UK)

17505 DISCUSSION OF AN EXPERIMENT TO MEASURE THE POLARIZATION OF DAYGLOW LYMAN ALPHA. **Donahue, T. M. (Univ. of Pittsburgh). Planet. Space Sci., 15: 1531-4(Oct. 1967).**

The results of a recent measurement of the degree of polarization of dayglow Lyman α are given. The upper limit of 1.5% polarization at 200 km is shown to be not inconsistent with that expected for a hydrogen atmosphere normalized to 3×10^7 cm^{-3} at 100 km. The observed horizon brightening of 32% between 32 and 65° solar zenith angle is also consistent with the model which is required to account for the bulk of airglow Lyman α observations. (auth) (UK)

17506 STUDIES OF AURORAL RADIO ABSORPTION EVENTS AT THREE MAGNETIC LATITUDES. I. OCCURRENCE AND STATISTICAL PROPERTIES OF THE EVENTS. **Hargreaves, J. K.; Cowley, F. C. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Planet. Space Sci., 15: 1571-83(Oct. 1967).**

The absorption of cosmic radio noise was observed with riometers situated at three pairs of magnetically conjugate sites in and around the auroral zones. Major properties of the events are summarized and the geographic distribution, the statistical properties, and effects associated with increased magnetic activity are derived. In general, the events occur in a diurnal pattern having two maxima; the pattern changes with latitude and with the level of planetary magnetic activity. Events have different properties by day and by night. The night group coincides with the distribution of bursts of 10-keV electrons detected on a low-altitude satellite. It appears that enhanced periods of absorption, lasting several days, are related to the passage of sectors of the solar wind. (auth) (UK)

17507 STUDIES OF AURORAL RADIO ABSORPTION EVENTS AT THREE MAGNETIC LATITUDES. II. DIFFERENCES BETWEEN CONJUGATE REGIONS. **Hargreaves, J. K.; Cowley, F. C. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Planet. Space Sci., 15: 1585-97(Oct. 1967).**

The analysis presented looks for relative differences between the events observed nearly simultaneously at magnetically conjugate stations in the northern and southern hemispheres. Significant hemispheric differences are found between the sites at the two highest latitudes. The relative magnitude of the events varies seasonally, diurnally, and with the direction of the interplanetary magnetic field. There are also significant time differences between the peaks of associated events. At some conjugate stations the relative magnitude and the time difference are related, the event tending to be larger at the station where it occurs first. Some mechanisms for conjugate differences are considered, and it is concluded that effects in the atmosphere are not responsible. The explanation is more likely to be found in relative movement of the conjugate points, or in the processes of generation and propagation of auroral particles. (auth) (UK)

17508 MIDLATITUDE ELECTRON AND ION TEMPERATURES AT SUNSPOT MINIMUM. **Evans, J. V. (Univ. of Illinois, Urbana). Planet. Space Sci., 15: 1557-70(Oct. 1967).**

Midlatitude F-region electron temperature profiles, determined by ground-based radar methods, indicate a positive gradient at all altitudes up to at least 700 km at sunspot minimum. This is not in accord with current theoretical ideas on the problem of the thermal balance in the ionosphere. According to these ideas the electron temperature should be almost isothermal above 300 km altitude, because of the absence of significant heat input at these altitudes and the high thermal conductivity of the electron gas. The results thus suggest the existence of heat sources above the ionosphere. The diurnal and seasonal variations of the electron temperature, and the gradient at 500 km altitude, are consistent with a model of photoelectron escape into the protonosphere which gives rise to this heating. Previous theoretical estimates indicate the energy deposited above 500 km by this means at 10^9 eV/cm^2/sec. The experimental results imply, in winter, a flux of $\sim 6 \times 10^9$ eV/cm^2/sec, and it is presumed that the theoretical value is too low because the number of escaping particles has been underestimated. (auth) (UK)

17509 INTERACTION BETWEEN A STEADY-STATE PLASMA AND A MAGNETIC FIELD. **Kim, Nak Goo; Singer, Stanley (Athenex Research Associates, Pasadena, Calif.). Phys. Fluids, 11: 453-4(Feb. 1968).**

The interaction of a plasma with 5×10^{13} proton/cm^3 at a velocity of 2×10^6 cm/sec and a dipole magnetic field of 130 G is studied. The magnetic pressure of this field approximately balances the pressure of the plasma at about 7 cm from the center of the dipole. (auth)

17510 STUDY OF THE IONIC VELOCITIES MEASURED AT NIGHT IN THE F REGION. **Bousquet, Claude; Vasseur, Guy (CNRS, Hauts-de-Seine, France). Compt. Rend., Ser. A and B, 265: 1069-72(Nov. 6, 1967). (In French).**

The knowledge of the ionization movements in the F layer of night, because of measurements made by the French diffusion probe, makes it possible to study for the first time the effects of these movements on the ionization. Only the vertical gradients of the velocity which intervene in the continuity equation are difficult to measure. Under certain conditions this term is not preponderant; it is then possible to verify that the ionization is governed by the velocities measured and to deduce therefore a value for the recombination coefficient of the ions. (tr-auth)

17511 COMPARISON OF THE VERTICAL DISTRIBUTIONS OF ^{222}Rn FROM 0 TO 4,500 M ABOVE THE ATLANTIC OCEAN, THE ANTARCTICA CONTINENT, AND THE PARIS REGION. **Nguyen Ba Cuong; Lambert, Gerard; Polian, Georges; Jacquin, Jean-Pierre (Centre d'Etudes Nucleaires de Saclay, Essonne, France. CNRS, Essonne, France. Expeditions Polaires Francaises, Paris). Compt. Rend., Ser. A and B, 265: 1065-8 (Nov. 6, 1967). (In French).**

A very simplified apparatus made it possible to measure the atmospheric concentration of Rn from 0 to 4,500 m of altitude above the Atlantic Ocean and the Antarctic continent and to compare them with the results obtained above France. With the exception of some limiting beds, this concentration seems constant as a function of the altitude. (tr-auth)

17512 GEOMAGNETIC MICROPULSATIONS AND DIAGNOSTICS OF THE MAGNETOSPHERE. **Troitskaya, V. A.; Gul'elmi, A. V. (Inst. of the Physics of the Earth, USSR). Space Sci. Rev., 7: 689-768(Dec. 1967).**

Plasma oscillations in a wide range of spectrum exist in the magnetosphere. Part of them penetrate the ionosphere and are recorded on the Earth's surface. In the range of frequencies from millihertz to several hertz, the so-called micropulsations (ulf) are observed. In the range from hundreds of hertz to several kilohertz the low-frequency emissions (vlf) are registered. Both types of emissions contain interesting and important information on the physical parameters of the magnetosphere and on the processes developing in it. The main problems of the diagnostics of the magnetosphere are described, which are based on the surface observations of micropulsations. A short summary of theoretical conceptions on micropulsations is given. The methods of diagnostics of the location of the boundary of the magnetosphere, of cold-plasma concentration in the outer regions of the magnetosphere are described, as well as of the energies and fluxes of fast charged particles in the geomagnetic trap. Some experimental results of the diagnostics of the parameters of the magnetosphere are given. Advantages and deficiencies of the existing methods of surface diagnostics are discussed, and the directions of further investigations are traced. (auth)

17513 MAGNETOSPHERIC ACTIVITY AND ITS CONSEQUENCES IN THE AURORAL ZONE. **Parthasarathy, R. (Univ. of Alaska, College); Reid, G. C. Planet. Space Sci., 15: 917-29 (May 1967).**

Bursts of energetic electrons in the magnetospheric tail were compared with the simultaneous radiowave absorption data in the auroral-zone. It was found that the tail bursts could be identified with the auroral-zone activity in a number of instances. It is therefore inferred that the lines of force pertaining to the auroral zone often reach out more than 15 Earth radii in the night side. It is also suggested that the activity in the tail may be the fundamental cause of auroral phenomena, the day-side auroral absorption zone being merely a consequence of the precipitation due to electrons travelling eastward from the tail. (auth) (UK)

17514 THE ORIGIN OF AFTERNOON "AURORAL" RADAR ECHOES. **Gadsden, M. Planet. Space Sci., 15: 893-8(May 1967).**

One of the puzzling, and hitherto unexplained, properties of vhf backscatter from the auroral electrojet is the occurrence of a thin, horizontal and remarkably uniform backscattering layer during the afternoon period. If the backscattering regions are in fact two-stream plasma instabilities, it is shown that the properties of the afternoon backscatter can be explained by invoking an electric field perpendicular to the magnetic field. (auth) (UK)

17515 ROCKET MEASUREMENTS OF THE VOLUME EMISSION PROFILE FOR AURORAL GLOW. **Maseide, Karl (Norwegian Inst. of Cosmic Physics, Oslo). Planet. Space Sci., 15: 899-905(May 1967).**

Two rockets carrying calibrated photometers were flown into auroral glow for measurement of the volume emission profile versus height of the N_2^+ first negative band (0−1) at λ 4278 Å. Luminosity profiles with maximum emission at about 100 km were recorded. The lower borders of the profiles appear to be rather sharp, with half-value distances from the maximum of 2 to 3 km. The upper half-value distances were in the range 8 to 11 km. Simultaneous measurements of the N_2^+ first negative band λ 4278 and the [O I] green line λ were made from the ground. (auth) (UK)

17516 NEW FACET OF THE HEATING OF AMBIENT ELECTRONS BY ENERGETIC CHARGED-PARTICLE STREAMS. Cole, K. D. (La Trobe Univ., Bundoora, Victoria). Planet. Space Sci., 15: 873-9(May 1967).

An energetic charged particle flux must often be accompanied by a reverse current of the same magnitude at the same place. In the ionosphere the Joule dissipation of such a reverse current heats the electron gas more than the direct Coulomb collisions of the energetic particles with the ambient electrons provided $FE/\phi \geq 3.5 \times 10^2 n_e^2 \nu_e^{-1}$ eV cm^{-2} sec^{-1}, where E is the average energy (in eV) of particles in the flux (F), and ϕ is a factor equal to or greater than 1, depending on whether or not all the energetic particles are moving in one direction only. For fluxes in which $\phi = 1$, the condition is satisfied by F values $>3 \times 10^{10}$ eV cm^{-2} sec^{-1} in and below the E-region and by values $>4 \times 10^{12}$ eV cm^{-2} sec^{-1} in the F-region. The rise in electron temperature caused by this indirect Joule dissipation, when heat conduction in the ambient electrons is small, is estimated, with special reference to auroral bombardment. (auth) (UK)

17517 POSSIBLE CONSEQUENCES OF THE ASYMMETRIC DEVELOPMENT OF THE RING CURRENT BELT. Swift, D. W. Planet. Space Sci., 15: 835-62(May 1967).

The consequences of an asymmetric injection of protons into the magnetosphere are investigated. A guiding center Vlasov equation is solved by a perturbation method, with the solution being given in terms of an electric potential. The electric potential is determined by the condition that the drift currents plus the ionosphere currents be divergenceless. The effect of the Earth's rotation is also included. The electric potential and ionospheric currents are seen to be critically dependent upon the ring current particle energy and ionospheric conductivity. The computations indicate substantial transfer of charge between the magnetosphere and ionosphere in auroral zone locations, and suggest that the ring current may have an important role in auroral processes. (auth) (UK)

17518 DYNAMICS OF AURORAL BELT AND POLAR GEOMAGNETIC DISTURBANCES. Feldstein, Y. I. (World Data Center, Moscow); Starkov, G. V. Planet. Space Sci., 15: 209-30 (Feb. 1967).

Using IGY−IGC all-sky camera films from many stations, the width and location of the auroral belt were determined. The positions of the edges were defined, at 15-min intervals, for different times of the day, and compared with the Q index of magnetic activity on the night side of the Earth. The dynamics of the auroral belt and the general morphology, including the rate of displacement of the northern and southern edges, the change in the belt width, and the asymmetry of aurorae on the night−day and morning−evening sides of the Earth, are discussed in connection with variations in the geomagnetic activity. The probability of a discontinuous auroral belt during weak magnetic disturbances is considered. The auroral distribution around midnight, during magnetically calm periods, is analyzed, and it is shown that, during both the IGY and IQSY, aurorae always appeared at 70° geomagnetic latitude. Variations in the azimuths of extended forms, for each of the 24 hr periods were obtained, and it is shown that the daily variations of the azimuths are determined by the shape of the auroral belt. The decrease of asymmetry of the auroral belt with increasing magnetic disturbance results in variations of the observed azimuths. A global schematic diagram, to illustrate the development of an auroral substorm, which is a generalization of the scheme proposed by Akasofu for the night side of the Earth, is given. (auth)

17519 CORRELATION BETWEEN THE 5577 A [O I] NIGHT AIRGLOW INTENSITY AND SOLAR ACTIVITY. Rosenberg, N.; Zimmerman, S. P. Planet. Space Sci., 15: 863-72(May 1967).

Several prior studies have demonstrated correlations between both mean annual and mean monthly intensities of the 5577 Å [OI] line of the night airglow and corresponding means of solar activity, expressed in terms of sunspot area or sunspot number. The present authors analyzed green line intensity measurements obtained at Sacramento Peak, New Mexico (32°43′N; 105°45′W) from November 1956 to June 1963 for correlation with two indices of solar activity, Zurich relative sunspot numbers and 10.7-cm solar flux. The analysis was performed on both a mean monthly and mean nightly basis, and was further subdivided (arbitrarily) in terms of solar-cycle phase. It was found that: (1) a statistically significant positive correlation exists between monthly and nightly averages of green line activity and both indices of solar activity; (2) the 10.7-cm flux shows a somewhat higher correlation with green line activity than is shown by Zurich relative sunspot number; (3) the degree of correlation is dependent on the phase of the solar cycle. It is suggested that other studies of solar activity and geophysical parameters might also show similar variations as a function of solar cycle phase. (auth) (UK)

17520 MAGNETOPLASMA DIFFUSION AT F2-REGION ALTITUDES. Kendall, P. C.; Pickering, W. M. (Univ. of Sheffield, Eng.). Planet. Space Sci., 15: 825-33(May 1967).

The magnetoplasma diffusion equation of the F2 region of the ionosphere is derived in its primitive form, allowing for electric currents flowing between conjugate points of the dynamo region, and for temperature variations. It appears that the standard view of the ambipolar diffusion problem is correct. The ion−electron pairs may be thought of as sliding down the magnetic field lines with diffusive motion, while the whole field line drifts at right angles to itself. The electric current along a field line would affect the ionization only if its magnitude were 1000 times greater than Dougherty's estimate [J. Geophy. Res., 68: 2383(1963)] of 10^{-7} A/m^2. (auth) (UK)

17521 STEADY-STATE MAGNETIC FIELD IN THE TRANSITION REGION BETWEEN THE MAGNETOSPHERE AND THE BOW SHOCK. Alksne, Alberta Y. (Ames Research Center, Moffet Field, Calif.). Planet. Space Sci., 15: 239-46(Feb. 1967).

The direction and intensity of the magnetic field throughout the transition region were calculated by use of the equations of magnetohydrodynamics for several orientations of the interplanetary field. The equations were solved by an approximate method appropriate for steady flow when the magnetic energy density is considerably less than the kinetic energy density of the flow. The resulting field lines are three-dimensional curves, having been distorted by the flow around the magnetosphere. Two projections are presented, one on a plane containing the free-stream velocity vector and field vector, and the other on a plane perpendicular to the free-stream velocity vector. Lines of constant flux density are shown on both projections. (auth) (UK)

17522 ARTIFICIAL STRONTIUM AND BARIUM CLOUDS IN THE UPPER ATMOSPHERE. Foeppl, H.; Haerendel, G.; Haser, L.; Loidl, J.; Luetjens, P.; Luest, R.; Melzner, F.; Meyer, B.; Neuss, H.; Rieger, E. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Planet. Space Sci., 15: 357-72(Feb. 1967).

Experiments with strontium and barium vapor releases in the upper atmosphere, carried out in the Sahara and in Sardinia in 1964, are discussed. The yield of evaporated metal was tested for different chemical reactions. No Sr ions were observed in the experiments. Barium, however, was strongly ionized. The ionization proceeds in two different steps: an initial phase, with a characteristic time of about 5 sec, and by a slower photoionization process, with a characteristic time of about 100 sec. The diameter of the neutral clouds increased as would be expected for purely molecular diffusion. The rate of increase of the central intensity of the clouds at sunrise was greater than the rate of decrease at sunset. Atmospheric wind velocities of 50 to 130 msec^{-1} were determined from the motion of the neutral clouds. The motion of the ion clouds perpendicular to the Earth's magnetic field indicated the presence of electric fields. The initial expansion velocity for explosive mixtures was greater by about a factor of four than the mean thermal velocity of the atoms at a temperature of about 3000°K. (auth) (UK)

17523 CHARACTERISTICS OF HIGH-FREQUENCY AURORAL PULSATIONS. Omholt, Anders; Pettersen, Helge (Auroral Observatory, Tromso, Norway). Planet. Space Sci., 15: 347-55 (Feb. 1967).

The power spectrum of pulsating aurora was measured in the frequency range 1 to 20 c/s. It showed consistently an exponential falloff with increasing frequency above about 1 to 2 c/s. It is shown that this is consistent with an assumption that the modulation mechanism in the flux of primary particles takes place at some distance from the atmosphere, the dispersion in energy smearing out pulsations at higher frequencies. (auth) (UK)

17524 DIURNAL VARIATION OF IONOSPHERIC TEMPERATURES. Dalgarno, A. (Queen's Univ., Belfast); McElroy, M. B.; Walker, J. C. G. Planet. Space Sci., 15: 331-45(Feb. 1967).

Average diurnal variations of ionospheric electron and ion temperatures were theoretically predicted for April, July, and November 1963 at a typical midlatitude station. The theory assumes heating by solar ultraviolet radiation, cooling by collisions, and allows for heat transport by conduction. The magnitudes of the predicted temperatures agree satisfactorily with observation, but there are significant differences between measured and computed profiles of electron temperature. The present results are consistent above 140 km with results of rocket flights, but not with results derived from measurements of incoherent backscatter. (auth) (UK)

17525 GENERAL PATTERN OF AURORAL PARTICLE PRECIPITATION. Hartz, T. R. (Defence Research Telecommunications Establishment, Ottawa); Brice, N. M. Planet. Space Sci., 15: 301-29(Feb. 1967).

Gross statistical data on optical- and radio-auroral phenomena are examined to establish the latitude-versus-time pattern for the causal particle precipitation. Although these phenomena may occur at any time of day at auroral-zone latitudes, they are shown to occur most frequently at about 08 and 22 hours geomagnetic time. These two dominant diurnal maxima exhibit radically different characteristics, indicating that two distinct particle populations are involved, on the average. Futhermore, the two types of precipitation are recognizable at other times of day in the statistical data, although at a reduced intensity. This leads to two-zoned precipitation pattern in which there is a clear separation between the zones during most of the day. The most prominent features of the precipitation in the zone with the night-time maximum are shown to be the impulsive character of the precipitation and its steep energy spectrum, whereas the zone with the morning maximum is best described as having a continuous influx with a much flatter particle spectrum. On the basis of detailed studies of these characteristics, of observations on other related ionospheric parameters, and of direct particle measurements made with rockets and satellites, it seems plausible to associate the two particle populations with different regions of the magnetosphere. This relationship to the magnetospheric structure, and to the processes therein is discussed for both the "splash" and "drizzle" types of precipitation. (auth) (UK)

17526 ELECTRON CONTENT OBSERVATIONS AT BRISBANE FOR 1965. Jones, K. L. (Univ. of Queensland, Brisbane). Planet. Space Sci., 15: 295-9(Feb. 1967).

Observation of Faraday fading of 40-Mc signals from satellites Explorer 22 (BE-B) and Explorer 27 (BE-C) at Brisbane (27.4°S, 207.5°W) yielded values of electron content for 435 passes in the period October 1964 to November 1965. Diurnal and seasonal variations of electron content and diurnal variation of equivalent slab thickness were investigated. Special interest was attached to the relation between electron content and scintillation occurrence. (auth) (UK)

17527 ORIENTATION OF AURORAL ARCS. Gustafsson, Georg (Kiruna Geophysical Observatory, Sweden). Planet. Space Sci., 15: 277-94(Feb. 1967).

Information on the direction of auroral arcs, mostly all-sky camera data during IGY, was collected and organized in a geomagnetic coordinate system, corrected by the higher order spherical harmonic terms. By interpolation and integration between the measured values it was possible to obtain curves in a polar plot representing auroral arcs over the polar region in the latitude range 64 to 90°. The ovals of auroral arcs do not follow the corrected geomagnetic latitudes. They are furthest from the pole on the night side, e.g., 70.5° at 24, 79.9° at 06, 79.2° at 12, and 75.5° of latitude at 18 hours. A small dawn—dusk asymmetry was also observed, the curves being closer to the pole at 06 hours than at 18 hours. In the polar region between latitudes 80 to 85° for a time interval around 1600 hours it was found that the auroral arcs have an angle relative to the solar direction of about 20°. The shape of the auroral orientation curves corresponds (in the auroral zone region) with the auroral oval based on the occurrence of aurora. (auth) (UK)

17528 DIRECT DETECTION BY A WHISTLER METHOD OF THE MAGNETOSPHERIC ELECTRIC FIELD ASSOCIATED WITH A POLAR SUBSTORM. Carpenter, D. L.; Stone, K. (Stanford Univ., Calif.). Planet. Space Sci., 15: 395-7(Feb. 1967).

The detection of a transient, large-scale magnetospheric electric field associated with a polar sub-storm, found by a method described by Carpenter (1966), is a new result. The main findings are: (i) As "viewed" by the observing whistler recorder, the electric field exhibits a rise time of less than 5 mins and a duration of 1.25 hrs. The onset of $\underline{E} \times \underline{B}$ drift motions near $L = 4.5$ preceded the sudden start of conjugated magnetic bay activity near $L = 7$ by about 28 mins. (ii) At a geocentric equatorial distance of about 4 R_E the electric field exhibited a westward component of 0.3×10^{-3} V/m, corresponding to a potential difference of 2 kv over a distance of R_E. The associated plasma motions were observed over the equatorial range 3.8 to 4.6 R_E, and involved inward velocities of about 700 M/sec (0.4 R_E/hr. (UK)

17529 AURORAL EXCITATION OF THE FORBIDDEN LINES OF ATOMIC OXYGEN. Rees, M. H. (Univ. of Colorado, Boulder); Walker, James C. G.; Dalgarno, A. Planet. Space Sci., 15: 1097-110(July 1967).

Excitation of the forbidden lines of atomic oxygen, λ 5577 and λ 6300, was investigated in detail. The calculations are based on a well-documented auroral arc observed in Alaska, for which height—luminosity profiles were obtained in λ 3914 from photometric triangulation. The $O(^1S)$ term is excited principally by secondary (non-ionizing) electrons produced by auroral bombardment; dissociative recombination of O_2^+ contributes about 30% to the photon emission rate. The $O(^1D)$ term is excited by several processes: secondary electron excitation predominates up to about 250 km, but quenching eliminates much λ 6300 radiation at these altitudes. Excitation by the thermal electron gas, which reaches a temperature of about 4500°K at high altitudes, dominates above 250 km. Diffusion of the excited $O(^1D)$ atoms broadens the region of emission of λ 6300 compared with the region of the atmosphere under bombardment. An electron density in excess of 10^6 cm^{-3} is reached in the aurora at 120 km, the altitude of maximum ionization. (auth) (UK)

17530 A TWO-ION D-REGION MODEL FOR POLAR CAP ABSORPTION EVENTS. Adams, G. W. (Douglas Aircraft Co., Santa Monica, Calif.); Megill, L. R. Planet. Space Sci., 15: 1111-30(July 1967).

The usual model of the chemistry of the lower ionosphere is inadequate to explain many observed phenomena. When this model is updated by the addition of associative detachment ($O_2^- + O \rightarrow O_3 + e$) and collisional detachment by excited $O_2(O_2^- + O_2(^1\Delta_g) \rightarrow 2O_2 + e)$, the disagreement between theory and experiment becomes larger instead of smaller. In this paper the existence of a second (unidentified) negative ion, X^-, is postulated, formed symbolically by $O_2^- + X \rightarrow X^- + O_2$, with rate ν_x. The product $\nu_x[X]$ is calculated as a function of altitude from daytime PCA data, and the two-ion model is then applied to twilight and nighttime PCA conditions and to nighttime nuclear burst conditions. Adequate agreement between theory and experiment is then obtained for all conditions. The existence of a second negative ion, therefore, seems well supported by this study, but the identity of X^- remains unknown. (auth) (UK)

17531 DURATION DISTRIBUTION OF RADIO ECHOES OBTAINED FROM UNDERDENSE SHOWER-METEOR TRAINS. Poole, L. M. G.; Kaiser, T. R. (Sheffield Univ., Eng.). Planet. Space Sci., 15: 1131-49(July 1967).

The distribution in decay times of radio echoes obtained from underdense trains formed by meteors associated with Perseid, Geminid, and Quadrantid meteor showers was measured for meteors in the radio-magnitude range 5.3^m to 6.8^m. The results indicate that ionization profiles are considerably shorter than predicted by the simple evaporation theory, that the geomagnetic field has an appreciable effect upon diffusion in meteor trains, and that the exponent n in the law $\rho_1 \propto \alpha_1^n$ (where α_1 is the maximum electron line density which occurs at a height where the atmospheric density is ρ_1) could be slightly larger than the theoretical value of $\frac{1}{2}$. It is shown that these results can be explained in terms of the ablation of single grain meteoroids. (auth) (UK)

17532 THERMAL DIFFUSION IN THE TOPSIDE IONOSPHERE. Walker, James C. G. (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci., 15: 1151-6(July 1967).

It is shown that thermal diffusion profoundly affects ion density gradients in the topside of the ionosphere. For charged particle temperatures increasing with altitude the effect is to decrease the He^+ and H^+ density gradients at altitudes where O^+ is the major ion, and to increase (algebraically) the He^+ and O^+ density gradients at altitudes where H^+ is the major ion. Rocket and satellite mass spectrometer data provide some evidence of these effects. (auth) (UK)

17533 CHANGES IN THE TOPSIDE IONOSPHERE DURING A LARGE MAGNETIC STORM. Titheridge, J. E.; Andrews, M. K. (Univ. of Auckland, New Zealand). Planet. Space Sci., 15: 1157-67(July 1967).

Continuous records of the total electron content of the ionosphere, obtained using signals from a geostationary satellite, were used to study the changes occurring during a large magnetic storm at midwinter, sunspot minimum (June 15–18, 1965). The results are compared with those obtained from a full analysis of ionograms taken at 15-min intervals over a period of 14 days. The peak density and the subpeak content showed the usual small, irregular variations. The changes in total content and in slab thickness were, however, large and systematic, with a significance level exceeding 99.99%. This suggests that total content measurements may give a much clearer picture of storm morphology. The mean scale height Γ above the peak of the F layer was calculated from the topside electron content and the scale height at the peak. There was an initial increase in Γ, from 0.2 to 0.4, caused by heating of the topside ionosphere or a sustained influx of electrons. At the peak of the storm Γ dropped to 0.03, showing that the scale height increased very slowly above the peak. This requires an increased mixing of the ionosphere to reduce the normal diffusive separation. The gradual recovery to normal values of scale height took 5 days. Calculations of the integrated loss rate also showed an increased mixing, giving more neutral molecules in the F region, which persisted for 5 days. (auth) (UK)

17534 METASTABLE HELIUM IN THE UPPER ATMOSPHERE. Patterson, T. N. L. (Queen's Univ., Belfast). Planet. Space Sci., 15: 1219-22(July 1967).

The altitude variation on the metastable helium atom abundance and the emission rate of helium 10830-Å radiation in the atmosphere are discussed. It is shown that the escape flux of neutral helium resulting from the reaction of metastable atoms and atomic oxygen is insufficient to explain the helium loss from the atmosphere. (auth) (UK)

17535 THE 5577/3914 A INTENSITY RATIO IN AURORAS. Dalgarno, A.; Khare, S. P. Planet. Space Sci., 15: 938-40 (May 1967).

A mechanism is suggested to explain the observation that the ratio of the intensity of the green O line to that of the first negative N_2 band is small and approximately constant over a wide range of auroral intensities and heights. The effect is to be expected if dissociative recombination of O_2^+ is the main source of $O(^1S)$ atoms, rather than electron impact of O. Such inelastic collisions are less efficient in dissipating the energy of the low energy secondary electrons than are elastic collisions with ambient electrons. (UK)

17536 TRANSEQUATORIAL DIFFUSION IN THE TOPSIDE IONOSPHERE. Rishbeth, H. (Radio and Space Research Station, Slough, Eng.). Planet. Space Sci., 15: 1261-5(Aug. 1967).

An estimate is made of the rate at which plasma diffuses along lines in the topside ionosphere, using a simplified model. It appears that diffusion can within hours, remove north–south asymmetry in the electron distribution in the equatorial F2 layer. Significant asymmetry could, however, be maintained by a meridional wind in the neutral air, of some tens of m/s. (auth) (UK)

17537 CHARACTERISTICS OF THE IRREGULAR PULSATIONS OF DIMINISHING PERIODS AND THEIR RELATIONS WITH THE VARIATIONS OF FLUX OF PARTICLES TRAPPED IN THE MAGNETOSPHERE. Generin, R. (Groupe de Recherches Ionospheriques, Saint-Maur, France); Lacourly, S.; Troitskaya, V. A.; Gokhberg, M.; Shepetnov, R. V. Planet. Space Sci., 15: 1239-59 (Aug. 1967). (In French).

By means of a systematic spectral analysis of the irregular pulsations of the Earth's magnetic field that were recorded at two geomagnetically conjugate stations it was possible to classify them in two categories (already introduced by Troitskays (1961)): the irregular pulsations of diminishing periods (IPDP) and the short irregular pulsations (SIP); the present study deals only with the former category. An IPDP consists of a broad-band noise (Δf ~0.3 to 0.6 c/s), the mean frequency of which suddenly increases (from ~0.5 to ~1.5 c/s in approximately 30 mn). Some stronger oscillations, with a rapidly increasing frequency, are superimposed on this noise. It is shown that these oscillations appear simultaneously at conjugate stations, and that they have an opposite polarization. The IPDP occur principally between 1700 and 0100 local time, at geomagnetic latitudes between ~55° and ~65°, and during periods of magnetic activity ($\Sigma K_p \sim 25$). They are related to the aurorae and to the appearance of an auroral sporadic-E layer. A comparison with satellite measurements made at the same time shows that the IPDP occur when there is: (a) a variation of the flux of low energy (~50 to 150 keV) trapped electrons, (b) a diminution of the size of the outer Van Allen belt, (c) an increase of the magnetic field in the tail of the magnetosphere. A discussion of the experimental results leads to the following hypothesis: the IPDP are generated by a wave-particle interaction with low energy protons (~10 to 100 keV) taking place at ~5 to 6 R_E. During the deconnexion of the geomagnetic lines of force which follows a sudden commencement, the interaction region moves towards the Earth, thus leading to an increase of the emitted frequency. It is inferred that the deconnexion of the magnetic field lines takes place at first on the evening part of the magnetosphere. (auth) (UK)

17538 THE POSSIBLE RELATIONSHIP BETWEEN THE AURORAL BREAKUP AND THE INTERCHANGE INSTABILITY OF THE RING CURRENT. Swift, D. W. (Univ. of Alaska, College). Planet. Space Sci., 15: 1225-37(Aug. 1967).

Morphological evidence is presented suggesting that the auroral breakup may be the result of an instability on the boundary of the ring current belt. This suggestion is examined quantitatively by studying the consequences of a dispersion relation which includes the effects of wave particle interactions and the depolarizing effects of a finitely conducting ionosphere in a dipole magnetic field. Assuming reasonable ionospheric and magnetospheric parameters, it is shown that qualitative agreement can be obtained between predicted growth rates and wavelengths and those observed by the all-sky camera. Relations between the auroral breakup and the polar magnetic substorm and the structure of the magnetospheric tail are suggested. (auth) (UK)

17539 MORPHOLOGY OF ELECTRON PRECIPITATION DURING AURORAL SUBSTORMS. Clark, T. A.; Anger, C. D. (Univ. of Calgary, Alberta, Can.). Planet. Space Sci., 15: 1287-1301(Aug. 1967).

A study of auroral substorms using coordinated measurements of a number of parameters at Ft. Churchill, Manitoba (L = 8) in October 1963 has yielded interesting conclusions on the electron precipitation close to the northern auroral boundary, the morphology of which appears to follow closely the working model proposed by Akasofu. Extensions to this model are suggested that include high-energy-electron precipitation (>30 keV) as determined from x-ray measurements at balloon altitudes. During surges and auroral substorms near local midnight, very localized precipitation of electrons with a wide spectrum of energies produced a sharp northern optical and radio absorption border which moved rapidly northwards and contained the auroral electrojet. During the decay phases of the substorms a region of high-energy precipitation receded southwards in advance of the northern border of luminous aurora, and appeared to be accompanied by the ionospheric electric current. The optical northern border produced no noticeable auroral absorption or magnetic activity on its southward overhead passage later in the substorm. Systematic spectral changes near the border indicated a softening of the electron spectrum above 40 keV with increasing northward position (or increasing L value), in agreement with satellite observations. Highly structured enhancements of precipitation of high-energy electrons occurred at times when small scale folds in auroral bands were reported during breakup, and at times of occurrence of Type-B aurora. (auth) (UK)

17540 COMMENTS ON "OBSERVATION OF THE AIRGLOW H_α EMISSION" BY E. B. ARMSTRONG. Donahue, T. M. (Univ. of Pittsburgh). Planet. Space Sci., 15: 1223(July 1967).

It is pointed out that Armstrong's conclusions [ibid., 15: 407-25 (Mar. 1967)] were based on comparison of his own results with predictions from a multiple scattering model described by Donahue [ibid., 12: 149-59(Feb. 1964)] in which a simplifying assumption was made concerning the daytime–nighttime average energy transition. The excessive Hα emission rate, compared with expectations on the basis of the single solar Lβ flux measurement, remains unexplained. (UK)

Low-Temperature Physics

17541 ATTENUATION OF QUASI-LONGITUDINAL WAVES IN INDIUM. Bliss, E. S.; Rayne, J. A. (Carnegie-Mellon Univ., Pittsburgh). Phys. Lett., 26A: 278-9(Feb. 26, 1968).

A rapid drop of the superconducting electronic attenuation in high-purity indium was observed just below T_c for quasi-longitudinal ultrasonic waves with propagation vectors in the (010) plane. The anisotropy of this effect appears to agree with approximate theoretical estimates. (auth)

17542 INHOMOGENEOUS DISTRIBUTION OF THE TRANSPORT CURRENT IN THE SUPERCONDUCTING SURFACE SHEATH. Martinoli, P.; De Trey, P. (Swiss Federal Inst. of Tech., Zurich). Phys. Lett., 26A: 311-12(Feb. 26, 1968).

By simultaneous measurements with dc and ac current on an evaporated Pb film in a field range $H_{cb} < H < H_{c3}$ an inhomogeneous current density was deduced. This current density distribution supports the surface flux pinning model proposed by Hart and Swartz. (auth)

17543 CRITICAL TEMPERATURE OF MIXTURES OF SUPERCONDUCTORS AND ANTHRAQUINONE. Meunier, F.; Burger, J. P.; Deutscher, G.; Guyon, E. (Faculte des Sciences, Orsay, France). Phys. Lett., 26A: 309-10(Feb. 26, 1968). (In French).

An increase in the T_c of superconducting metals mixed with polarizable molecules was observed. The results are discussed in the light of recent theories of enhancement of T_c. (auth)

17544 STIMULATED BRILLOUIN SCATTERING IN LIQUID HELIUM. Winterling, G.; Walda, G.; Heinicke, W. (Technische Hochschule, Munich). Phys. Lett., 26A: 301-2(Feb. 26, 1968).

The threshold power for stimulated Brillouin scattering in liquid helium agrees with the value expected from its photoelastic properties and is temperature independent from 1.3 up to 3.8°K, including the vicinity of the λ point. There is no dispersion in the velocity of sound between 12 and 700 MHz. (auth)

17545 TRANSPORT OF HEAT IN A TYPE-I SUPERCONDUCTOR BY A MOVING MAGNET. Siafaca, E.; Trousdale, W. L. (Wesleyan Univ., Middletown, Conn.). Phys. Lett., 26A: 295-6(Feb. 26, 1968).

An experiment was performed to measure the heat carried by a small region of normal metal created in a superconductor by a magnetic field as the region moves through the superconductor. In the limit of low velocities it is found that all the excess heat in the normal region moves with the region. (auth)

17546 MECHANICAL ENTROPY TRANSPORT IN SUPERCONDUCTORS. Solomon, P. R. (United Aircraft Research Labs., East Hartford, Conn.). Phys. Lett., 26A: 293-4(Feb. 26, 1968).

The entropy transported when a magnet pulls a normal spot through a superconductor was measured. The entropy transported per quantum of flux is compared with the corresponding quantity determined from Ettingshausen effect measurements. (auth)

17547 ANISOTROPY OF THE ULTRASONIC ATTENUATION IN PURE TYPE II SUPERCONDUCTORS. Kinder, H. (Univ., Goettingen, Ger.). Phys. Lett., 26A: 319-20(Feb. 26, 1968).

The dependence of the attenuation on the magnetic field direction is derived from Maki's theory without restrictions on ql and considerable anisotropy is found even for $ql < 1$. (auth)

17548 BORON ISOTOPE EFFECT IN SUPERCONDUCTING ZIRCONIUM DODECABORIDE. Chu, C. W.; Hill, H. H. (Univ. of California, San Diego, La Jolla). Science, 159: 1227-8(Mar. 15, 1968).

The boron isotope effect in ZrB_{12} has been determined to be $T_c \propto M^{\alpha}$, where α is equal to -0.09 ± 0.05, M is the boron mass, and T_c is the superconducting transition temperature. (auth)

17549 FAR-INFRARED ABSORPTION SPECTRA OF THICK SUPERCONDUCTING FILMS. Norman, Scott L. (Univ. of Chicago). Phys. Rev., 167: 393-407(Mar. 10, 1968).

The absorption spectra of thick evaporated films of Pb, Sn, In, V, Ta, and Nb were examined in the superconductive energy-gap region by a calorimetric detection technique. The intensity available from the far-infrared monochromator, together with the improved sensitivity of the detection system, made it possible to employ modulation techniques to obtain the derivatives of the absorption spectra of the samples. Multiple energy gaps were found for a Sn film and two thick Pb films, while a thinner Pb film and the other samples had single gaps. It is suggested that these are the first far-infrared measurements to reveal multiple absorption edges in films. The energy gaps found for the two thick Pb films were $(4.18 \pm 0.04)\ kT_c$ and $(4.46 \pm 0.04)\ kT_c$ for one, and $(4.28 \pm 0.04)\ kT_c$ and $(4.65 \pm 0.04)\ kT_c$ for the other. For the Sn film, the gaps were $(3.58 \pm 0.02)\ kT_c$ and $(3.86 \pm 0.04)\ kT_c$. The gaps found for the other samples, in units of kT_c, were: for the thin Pb film, 4.34 ± 0.02; for In, 3.69 ± 0.04; for V, 3.4 ± 0.1; for Ta, 3.5 ± 0.2; and for Nb, 3.6 ± 0.2. These values are more precise than the earlier far-infrared results; in addition, the anomalously low values of $\sim 3kT_c$ obtained in previous far-infrared experiments for the Ta and Nb gaps are not reproduced in this work. The observed absorption edges are steeper than those predicted by either the extreme local or extreme anomalous limits of skin-effect theory. The energy gap of a thick Pb sample was measured as a function of magnetic field, this being the first such measurement by far-infrared calorimetric techniques. The gap was found to decrease by approximately 7% in going from zero field to the critical field for the bulk material (H_{cb}), in fair agreement with the Ginzburg–Landau theory. No gap was observed above H_{cb}, in agreement with previous observations on the superconducting surface sheath. (auth)

17550 CHARACTERISTIC PARAMETERS OF A GRANULAR SUPERCONDUCTOR. Parmenter, R. H. (Univ. of Arizona, Tucson). Phys. Rev., 167: 387-92(Mar. 10, 1968).

Starting from a simple microscopic model of a granular superconductor (cubic grains of superconductor weakly coupled by Josephson junctions separating adjacent cubes), a calculation is made of the characteristic parameters F and C of the continuum model of a granular superconductor, F being the proportionality constant of the tunneling energy, and C the proportionality constant of the electrostatic energy density. From these are calculated the characteristic frequency ω for the onset of electromagnetic oscillations, the characteristic length ξ, the Ginzburg–Landau coherence distance ξ_{GL}, and the magnetic penetration depth λ. The last two are identical with the corresponding quantities for a dirty superconductor in the vicinity of the superconducting transition temperature. In the limit of weak magnetic fields, the identity of λ holds for all temperatures. (auth)

17551 SUPERCONDUCTING THIN FILM IN A MAGNETIC FIELD: THEORY OF NONLOCAL AND NONLINEAR EFFECTS. I. SPECULAR REFLECTION. Thompson, R. S.; Baratoff, A. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 167: 361-81 (Mar. 10, 1968).

A self-consistent perturbation solution of the Gor'kov equations for a superconducting film in a strong parallel magnetic field is presented. The order parameter is assumed constant in space, but proper allowance is made for nonlocal effects, important when the thickness d is comparable to or smaller than the pair-correlation distance ξ, as is often realized in practice. Specular reflection simplifies the mathematical analysis: The usual momentum-space representation and impurity averaging procedures for Green's functions are shown to apply without essential modifications. Size quantization can be ignored as long as $p_F d^2/\xi \gg 1$. The Ginzburg–Landau and Maki local theories, valid in the vicinity of the transition temperature and in the dirty limit, respectively, are generalized. The modified equations for the current density, order parameter, free energy, and critical fields are studied in detail and compared with previous semiphenomenological extensions by Bardeen, Toxen, and others. An expression for the critical field H_c valid in the intermediate temperature and purity range is also obtained. The convergence of our perturbation expansion and the assumed constancy of the order parameter are shown to require $(e/c)H_c d\xi$ and $(e/c)H_c d^2 \ll 1$, respectively. An inconsistency in Rickayzen's alternative to Maki's theory is pointed out. The most important results, together with their ranges of validity, are indicated in the last section. (auth)

17552 THERMAL CONDUCTIVITY OF SUPERCONDUCTING TIN FILMS IN A MAGNETIC FIELD. Smith, John E. Jr.; Ginsberg, D. M. (Univ. of Illinois, Urbana). Phys. Rev., 167: 345-60(Mar. 10, 1968).

The magnetic-field dependence of the thermal conductivity of superconducting tin films was measured in a parallel field ranging from zero to above the critical fields, and at temperatures from 0.3 to 1°K. The electron mean free path l ranged from 18 to 85% of the bulk coherence length ξ_0. The Ginzburg–Landau parameter κ was sufficiently enhanced by the effect of the short mean free path that in the thicker films the surface sheath region of de Gennes and Saint James was observed. An expression is given for the field dependence of the thermal conductivity in this region, based on theoretical calculations of Caroli and Cyrot and of Maki; this expression, which is strictly valid only in the dirty limit $l/\xi_0 \to 0$, is in good agreement with our experimental results. The field dependence of the thermal conductivity of the thinner films is compared with theoretical expressions derived by Maki. These expressions are also restricted in validity to the dirty limit. Here the agreement between the theory and the data is not as good as for the thick films, but it improves as the experimental values of l approach the dirty limit. (auth)

17553 TRANSITION TEMPERATURE OF STRONG-COUPLED SUPERCONDUCTORS. McMillan, W. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 167: 331-44(Mar. 10, 1968).

The superconducting transition temperature is calculated as a function of the electron–phonon and electron–electron coupling constants within the framework of the strong-coupling theory. This theoretical result is used to find empirical values of the coupling constants and the "band-structure" density of states for a number of metals and alloys. It is noted that the electron–phonon coupling constant depends primarily on the phonon frequencies rather than on the electronic properties of the metal. Finally, using these results, one can predict a maximum superconducting transition temperature. (auth)

17554 BOUNDARY CONDITION ON THE ORDER PARAMETER AT A TUNNELING BARRIER IN A PURE SUPERCONDUCTOR ($T = T_c$). Boyd, R. G. (Univ. of Colorado, Boulder). Phys. Rev., 167: 407-12(Mar. 10, 1968).

The nucleation of superconductivity at a δ-function plane barrier in a free-electron superconductor is considered. The exact kernel of Gorkov's linear integral equation for the order parameter Δ is calculated and compared with the kernel derived by de Gennes for a similar model on the basis of a correlation-function argument not rigorously justified as yet. The two kernels are not the same, particularly near the barrier, but the difference oscillates with wavelength π/k_F and is negligible for the purpose of calculating asymptotic boundary conditions on the order parameter. Thus is confirmed for this model the boundary condition predicted by de Gennes, $\psi_+ = \psi_- + ((1 - t)/\phi))\xi_0 d\psi/dx|_0$. (auth)

17555 QUANTIZED PHASE EFFECT AND JOSEPHSON TUNNELING. Nieto, Michael Martin (State Univ. of New York at Stony Brook). Phys. Rev., 167: 416-18(Mar. 10, 1968).

By using properly defined sine and cosine phase variables, a model is proposed which yields a rigorous quantum-mechanical derivation of Josephson tunneling with exact current eigenstates. The model predicts that for dc tunneling the coherent fluids on both sides of the junction must be in the same state, and the "phase is quantized." This prediction can, in principle, be investigated experimentally and may afford a fundamental test of quantum mechanics. (auth)

17556 COHERENCE AND QUANTIZATION IN NEARLY SUPERCONDUCTING RINGS. Zimmerman, J. E.; Silver, A. H. (Ford Motor Co., Dearborn, Mich.). Phys. Rev., 167: 418-20 (Mar. 10, 1968).

New experiments demonstrating macroscopic coherence and quantization in partially resistive superconducting rings with point contacts are described. These include: (1) the observation of quantized magnetic transitions for frequencies $\omega > \omega_1 = R/L$, where R is the resistance and L the inductance of the ring, and (2) the measurement of coherent oscillations at frequencies limited by thermal noise fluctuations, $8k_BTR/\Phi_0^2$, where k_B is Boltzmann's constant, T the absolute temperature, and Φ_0 the flux quantum. These results are interpreted by introducing into the phenomenological model of weakly connected superconducting rings a continuous time dependence of the quantum states. (auth)

17557 MAGNETIC FIELD DEPENDENCE OF FAR-INFRARED ABSORPTION IN THIN-FILM SUPERCONDUCTORS. Martin, W. S.; Tinkham, M. (Univ. of California, Berkeley). Phys. Rev., 167: 421-9(Mar. 10, 1968).

The absorption of far-infrared radiation in a cavity by superconducting lead films was measured as a function of magnetic field up to the critical field. The experiments were conducted over a frequency range of 8 to 60 cm^{-1} on films approximately 100 Å thick in a magnetic field nearly parallel to the film plane. Even for fields well below the critical value, substantial absorption was observed below the gap frequency and apparently extending down to very low frequencies. This low-frequency absorption is much stronger than can be accounted for in terms of a spatially uniform order parameter being depressed by the field. Rather, it is postulated that vortices with normal cores resulting from the unavoidable, though small, perpendicular-field component play an essential role. In this way the data can be qualitatively interpreted, but at present no available theory is capable of giving a quantitative account of them. (auth)

17558 ON THE LOGARITHMIC SINGULARITY OF THE SPECIFIC HEAT OF He II. Stenschke, H.; Falk, G. (Technische Hochschule, Karlsruhe, Ger.). Z. Phys., 210: 111-12(Feb. 5, 1968).

The well known singular behavior of the specific heat at the λ point of liquid helium can be understood on the basis of an extended Ginzburg–Landau type theory in which spatial fluctuations of the order parameter are incorporated. (auth)

17559 PREPARATION AND SUPERCONDUCTIVE PROPERTIES OF NIOBIUM NITRIDE AND NIOBIUM NITRIDE WITH ADMIXTURES OF TITANIUM, ZIRCONIUM, AND TANTALUM. Horn, G.; Saur, E. (Univ., Giessen, Ger.). Z. Phys., 210: 70-9(Feb. 5, 1968). (In German).

The preparation of samples of niobium nitride with and without admixtures of Ti, Zr, and Ta by diffusion of nitrogen under pressure into Nb wires with and without the additives is described. An investigation of the effect of nitrogen content on the superconducting transition temperature of niobium nitride of different compositions resulted in transition temperatures not exceeding 16.5°K even for the stoichiometric composition NbN. The critical temperature, lattice parameters, and nitrogen content as a function of the additive content are given for diffusion wires of the systems $(Nb-Ti)N_x$, $(Nb-Zr)N_x$, and $(Nb-Ta)N_x$. The magnetization curve of niobium nitride was measured, showing the behavior of type-II superconductors. In formation of niobium nitride by diffusion, the nitrogen content increases with increasing diffusion temperature at constant nitrogen pressure, then decreases in the high-temperature region. (auth)

17560 JOSEPHSON CURRENT LIMITED BY SELF FIELD. Yamashita, Tsutomu; Kunita, Masanori; Onodera, Yutaka (Tohoku Univ., Sendai). Jap. J. Appl. Phys., 7: 288-90(Mar. 1968).

The maximum Josephson current I_{Jmax} is affected by the self field in ordinary junctions. The self field limiting I_{Jmax} is discussed. It makes clear quantitatively how much smaller the maximum I_J is than the calculation by Ambegaokar and Baratoff. (auth)

17561 SURFACE POWER LOSS OF ALTERNATING CURRENT IN HARD SUPERCONDUCTING WIRE. Yamada, N.; Kogawa, M. (Tokyo Univ.). Jap. J. Appl. Phys., 7: 291(Mar. 1968).

The resistive voltage wave forms of short samples of Nb–25% Zr wire (0.25 mm in diameter) was investigated with an applied sinusoidal current of 50 c to 50 kc at 4.2°K. The length of the sample wires was chosen short, with measured part 10 cm long, in order to avoid the influence of possible change of superconducting properties along their lengths, and to simplify electromagnetic field distribution along their lengths. The reactive component of the measured voltage, which has 90° phase difference relative to the current, is compensated through the electromagnetic coupling between the measured voltage and the current by use of a properly adjusted variable mutual inductance. (M.O.W.)

17562 PERFORMANCE OF A SOLUTION REFRIGERATOR. Varoquaux, Eric J.-A. (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. A and B, 265: 1372-5(Dec. 18, 1967). (In French).

A refrigerator using helium-3 solution in helium-4 was constructed and the preliminary tests made it possible to attain a temperature of 0.07°K. This temperature was measured with the aid of carbon resistances to ±0.01°K. The method of calibration of these resistances is considered in detail. The results obtained conform to theory. (tr-auth)

17563 OPTICAL CHARACTERISTICS OF A SUPERCONDUCTING LENS WITH DYSPROSIUM POLES. Bonjour, Pierre; Septier, Albert (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. A and B, 265: 1392-5(Dec. 18, 1967). (In French).

The curves giving the axial distribution of the magnetic field were obtained experimentally and then represented approximately by simple analytical functions. The calculation of the optical elements and of the aperture aberration and chromatic constants was made for high-energy electrons (0.75 to 4 MeV); the values obtained lead to theoretical separation capacities of the order of 0.5 Å between 2 and 3.5 MV. (tr-auth)

17564 THIRD SOUND IN ADSORBED SUPERFLUID FILMS. Rudnick, I. (Univ. of California, Los Angeles); Kagiwida, R. S.; Fraser, J. C.; Guyon, E. Phys. Rev. Lett., 20: 430-2(Feb. 26, 1968).

It is the purpose of this letter to report a new method of generating and detecting third sound and to present some results for unsaturated superfluid films. The system used utilizes an electrical current in a deposited metallic film as a thermal source and the receiver, a thin aluminum film, responds to the temperature changes in the wave. (W.D.M.)

17565 SUPERCONDUCTOR–GLASS VACUUM SEALS. Critchlow, P. R.; Lees, J.; Matthews, P. W. (Univ. of British Columbia, Vancouver). Rev. Sci. Instrum., 39: 251-3(Feb. 1968).

It was found to be possible to make a direct superconductor–glass seal, at the expense of some drop in the critical current wire. The type of seal used is similar to the Dumet type of copper–glass seal. A copper-coated wire was beaded with glass by melting a closely fitting sheath around the wire; the bead was then sealed into a 6-mm-diam. tube of lead glass. Seals using both Nb–Ti and Nb–Zr wire were made. (M.H.R.)

17566 NUCLEAR RELAXATION IN SUPERCONDUCTING NIOBIUM NEAR THE UPPER CRITICAL FIELD. Cyrot, M.; Froidevaux, C.; Rossier, D. (Faculte des Sciences, Orsay, France). Phys. Rev. Lett., 19: 647-9(Sept. 11, 1967).

Measurements of T_1 in pure niobium near H_{c2} are reported. The new point is, essentially, that in this region the distance between vortices becomes comparable with the coherence length. T_1 was measured in two different samples of niobium powder (I and II) with average particles of 15 μ. The upper critical fields at zero temperature were $H_{c2I} = 8.2$ kG and $H_{c2II} = 12.1$ kG. Most of the measurements were done at 1.4 to 4.2°K in fields from 3 to 9 kG. (W.D.M.)

17567 LATTICE MODEL FOR THE λ TRANSITION IN A BOSE FLUID. Bowers, R. G.; Joyce, G. S. (King's Coll., London). Phys. Rev. Lett., 19: 630-2(Sept. 11, 1967).

The critical properties of a lattice of planar classical "spins," which can be considered as a model for the λ transition in a Bose fluid, are studied using high-temperature series expansions. It is conjectured that in three dimensions the critical exponents $(T > T_c)$ for the specific heat and susceptibility of the model are $\alpha = 0$ (corresponding to a logarithmic singularity and $\gamma = 1\frac{5}{16}$, respectively. (auth)

17568 CRYOGENICS AND NUCLEAR RESEARCH. Pearce, Donald G. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Energy, 18-25(Jan.-Feb. 1968).

The physical and mechanical properties of working fluids and structural materials in the range 0 to 120°K are briefly discussed. The uses of cryogenic liquids are described; insulation and safety are also considered. Mention is made of applications of cryogenics in industry, and a more detailed resumé is given of laboratory and research applications, particularly in the nuclear field. (UK)

17569 LOW TEMPERATURE SPECIFIC HEAT OF THE FERMI LIQUID. Misawa, Setsuo (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 38: 1207-15(Dec. 1967).

It is shown that the recent theory by Doniach and Engelsberg to emphasize the effect of spin fluctuations for description of nearly ferromagnetic Fermi liquids is not compatible with experiment for liquid ^{3}He, when the renormalization effect is rightly taken into account. One of their conclusions that the spin fluctuations do not influence the susceptibility is also shown to be unreasonable. The observed low-temperature variation of the specific heat in a Fermi liquid, ^{3}He, can be explained without the concept of the spin fluctuations, through the individual quasi-particle excitations correlating with collective oscillations and other quasi particles. (auth)

17570 SOME PROBLEMS OF RELATING THE CRITICAL CURRENT DENSITY TO DISLOCATION DISTRIBUTION IN WORKED SUPERCONDUCTING ALLOYS. Baker, C.; Taylor, M. T. (Central Electricity Research Labs., Leatherhead, Eng.). Phil. Mag., 16: 1129-32(Dec. 1967).

In cold-rolled superconducting alloys both the critical current density, J_c, and the dislocation structure are anisotropic. The importance is shown of observing the dislocation distribution in a plane containing the Lorentz force when attempting to correlate J_c with defect structure. (auth) (UK)

17571 ULTRASONIC ATTENUATION IN NORMAL AND SUPERCONDUCTING INDIUM. Sinclair, A. C. E. (Univ. of Bristol, Eng.). Proc. Phys. Soc. (London), 92: 962-76(Dec. 1967).

Measurements were made of the variation of ultrasonic attenuation in indium between 4.2 and 1.3°K for longitudinal waves at 50 and 90 Mc and for transverse waves at 50 Mc. The results were analysed to determine the electronic contribution to the total attenuation. Low-amplitude dislocation attenuation was significant. Amplitude-dependent attenuation was investigated qualitatively. The electronic attenuation and the electronic mean free path were very anisotropic. The transverse normal-state attenuation decreased with decreasing temperature, in spite of the increasing mean free path. The results are discussed in terms of a suggested mean-free-path reduction near the edges of the Fermi surface in the reduced-zone scheme. The anisotropies are attributed to the combination of a sharply peaked electronic distribution function under the action of the ultrasonic wave, a Fermi surface with sharp edges, and a high probability of small-momentum scattering by thermal phonons. For propagation along [110] the value of the average deformation parameter K_z is calculated to be equal to the free-electron value. For propagation normal to (111) K_x is 26% greater than this value. These results, together with the large observed transverse attenuation in the superconducting state, indicate that band structure effects on the deformation parameters for indium are appreciable. (auth) (UK)

17572 EQUILIBRIUM AND STABILITY OF NORMAL AND SUPERCONDUCTING CURRENT LOOPS. Rebhan, E.; Salat, A. (Institut fuer Plasmaphysik, Munich). Z. Naturforsch., 22A: 1920-6(Dec. 1967).

The conditions for equilibrium and stability of a normal or a superconducting current loop in the magnetic field of other fixed loops are derived from the energy principle, both with and without a gravitational field. While loops with finite resistance cannot be levitated, stable equilibrium arrangements of superconductors can be found. In this connection a sufficient criterion for the indefiniteness of homogeneous multilinear forms $\Sigma_{k_1 \ldots k_n} T_{k_1 \ldots k_n} X_{k_1} \ldots X_{k_n}$ was derived and applied. (auth)

17573 SUPERCONDUCTIVITY IN THE MERCURY-TIN SYSTEM. Claeson, T. (Chalmers Univ. of Tech., Goteborg). Phys. Status Solidi, 25: K95-8(Feb. 1, 1968).

The superconducting transition temperature of Hg-Sn samples containing 80 to 95% Sn was measured as a function of composition. Results indicated an intermediate γ phase extending from 87 to 94% Sn; in this range T_c rose almost linearly from 4.6 to 5.1°K. It is noted that the increase coincides with an increase in number of valence electrons per atom of 3.74 to 3.88. (A.G.W.)

17574 ULTRASONIC ATTENUATION OF ANISOTROPIC SUPERCONDUCTOR IN ql ≪ 1 LIMIT. Yeh, R. H. T. (Univ. of Illinois, Urbana). Phys. Status Solidi, 25: 551-5(Feb. 1, 1968).

The ultrasonic attenuation coefficient α_s, for an anisotropic superconductor in the q l ≪ 1 limit, is expressed in terms of a power series expansion of the parameter of anisotropy, a. It is shown that the α_s anomaly as proposed by Kadanoff and Pippard cannot occur. This is because there exist geometrical factors in the expression of α_s, which are sufficient to compensate the divergence in the relaxation time. (auth)

17575 HYSTERESIS IN THE SUPERCONDUCTING TRANSITION OF SINGLE SPHERES OF INDIUM. Feder, J.; McLachlan, D. S. (IBM Research Lab., Zurich). Solid State Commun., 1: 23-6(Jan. 1968).

Superheating and supercooling of single spheres of indium, 6 to 50 μm in diameter, were investigated and compared with results from powder samples. The results give $\kappa(T_c) = 0.062$. A marked size effect near T_c was observed for the smaller spheres. (auth) (UK)

17576 RATIO OF THE UPPER TWO CRITICAL FIELDS IN PURE NIOBIUM. Webb, G. W. (Univ. of California, San Diego). Solid State Commun., 1: 33-6(Jan. 1968).

The ratio $C = H_{c3}/H_{c2}$ was measured for very pure superconducting niobium. The ratio was found to be temperature-dependent rising from about 1.67 at T_c to about 1.9 at lower temperatures. The results are compared with theory near T_c. (auth) (UK)

17577 SURFACE SUPERCONDUCTIVITY, SUPERCOOLING AND SUPERHEATING OF STRONG-COUPLING SUPERCONDUCTORS: LEAD AND MERCURY. Smith, F. W.; Cardona, M. (Brown Univ., Providence). Solid State Commun,. 1: 37-43 (Jan. 1968).

The surface nucleation field H_{c3} and the bulk superheating field H_{sh} were measured from 1.2°K to the transition temperature T_c for the two strong-coupling superconductors Pb and Hg. The results are given in terms of the Ginzburg-Landau parameters κ_1 and κ_{sh} as functions of T. Measured values of $-\partial H_{c3}(T_c)/(\partial T)$ are compared with recent theoretical predictions; good agreement is found. Results for the weak-coupling superconductors Sn and In are included for comparison. (auth) (UK)

17578 ASYMMETRIC CRITICAL CURRENTS IN A TYPE-I SUPERCONDUCTOR. Hansen, O. P.; Rasmussen, F. B. (Univ. of Copenhagen). Solid State Commun., 1: 49-51(Jan. 1968).

The phenomenon of "single surface rectification", known for type-II superconductors, was also observed in pure lead. The sense of rectification is opposite to that observed in the mixed and surface superconducting states of type-II superconductors. (auth) (UK)

17579 SUPERCONDUCTING CONTACTS UNDER MECHANICAL LOADS. Thomas, T. R.; Probert, S. D. (Univ. Coll. of Swansea, Wales). Surface Sci., 6: 388-90(Mar. 1967).

Outline of a method of separating the effects of two factors which dictate the real contact area of superconducting contacts: (1) the number of individual contacts and (2) their average size. A model is considered of a plane interface between two superconductors, across which there are on the average n bridges of electrical contact per unit area, each of average radius $\bar{a}$. If a current I (in amperes) is passed across the interface, the magnetic field H (in oersteds) produced at the surface of each contact bridge will be given by $H = 2I/n\bar{a}A$, provided $\bar{a}$ is large compared with the penetration depth δ. (IAA)

17580 NONLINEAR EFFECTS IN THIN SUPERCONDUCTING TIN FILMS AT MICROWAVE FREQUENCIES. Churilov, G. E.; Dmitriev, V. M.; Mende, F. F.; Khristenko, E. V.; Dmitrenko, I. M. (Physical-Technical Inst. of Low Temperatures, Kiev). JETP Lett. (USSR) (Engl. Transl.), 6: 222-4(Oct. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 752-5(Oct. 1, 1967).

17581 TEMPERATURE DEPENDENCE OF THE ENERGY GAP IN SUPERCONDUCTING $Al/Al_2O_3/Al$ TUNNEL JUNCTIONS. Blackford, B. L.; March, R. H. (Dalhousie Univ., Halifax, Nova Scotia). Can. J. Phys., 46: 141-5(Jan. 15, 1968).

The most detailed measurements of the energy gap in Al by the tunneling technique have been made using $Al/Al_2O_3/Pb$ junctions. Determination of the energy gaps from the I-V curves of these junctions is more precise than previous results using $Al/Al_2O_3/Al$ tunnel junctions. The chief difficulty with the $Al/Al_2O_3/Al$ junctions has been the lack of definition in the I-V curves, especially near T_c. $Al/Al_2O_3/Al$ junctions, in which the energy-gap voltages can be read from the I-V curve with very little ambiguity up to $T/T_c \approx 0.99$, are reported here. For the majority of the junctions studied, the temperature dependence of the normalized gap $\Delta(t)/\Delta(0)$ shows very little scatter ($T = 0.34$°K to $T = T_c$) and agrees closely with the BCS theory. However, a consistent small deviation is observed, with the measured gap values being slightly higher than the BCS prediction. The mean value of $2\Delta(0)/k_BT_c$ obtained from 21 different junctions is 3.53 with an rms deviation of ±0.02. (auth) (Canada)

17582 NONLINEAR PROPERTIES OF A SUPERCONDUCTING LEAD FILM AT MICROWAVE FREQUENCIES. Peskovatskii, S. A.; Eru, I. I.; Barilovich, O. I. (Inst. of Radiophysics and Electronics, Kiev). JETP Lett. (USSR) (Engl. Transl.), 6: 227-8(Oct. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 759-62(Oct. 1, 1967).

17583 INTRINSIC QUANTUM FLUCTUATIONS IN UNIFORM FILAMENTARY SUPERCONDUCTORS. Webb, W. W.; Warburton R. J. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 20: 461-5(Feb. 26, 1968).

Small depressions of supercurrent and critical temperature that indicate intrinsic thermodynamic fluctuations have been revealed in thin superconducting tin whisker crystals. (auth)

17584 APPARENT VIOLATION OF GRIFFITHS' INEQUALITY FOR ^{4}He. Coopersmith, Michael H. (Case Western Reserve Univ., Cleveland). Phys. Rev. Lett., 20: 432-4(Feb. 26, 1968).

A reanalysis of the data used to determine the critical exponent δ given by Roach and Douglass in a recent letter shows that the value of this exponent is significantly larger than the value they obtained and satisfies Griffiths' inequality. (auth)

17585 CONCERNING THE SUPERCONDUCTIVITY OF THE ALLOYS OF THE SYSTEM Nb_3Al–Nb_3Ge. Ageev, N. V.; Alekseevskii, N. E.; Mikhailov, N. N.; Shamrai, V. F. (Inst. of Metallurgy, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 329-31(Nov. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 901-4(Nov. 15, 1967).

The superconducting transition temperatures of alloys of the system Nb_3Al-Nb_3Ge were investigated at compositions close to that at which a maximum T_c was previously found (~20% Nb_3Ge). Alloys were prepared by sintering the powdered metals at 2000°C in a He atmosphere. The samples were then heated for 100 hr at 900° in Ar and quenched in water at 0°C. Measurements of the magnetic moments and the transition curves after sintering and after heat treatment showed that the critical temperature of the sample increased appreciably after heat treatment. The maximum value obtained for T_c was 19.1°K. Possible explanations for the increase in T_c are considered. (A.G.W.)

17586 INFLUENCE OF QUANTUM FLUCTUATIONS ON THE WIDTH OF THE BAND OF RADIATED FREQUENCIES IN A SUPERCONDUCTING TUNNEL STRUCTURE. Ivanchenko, Yu. M. (Donets Physico-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.), 6: 313-15(Nov. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 879-81(Nov. 1, 1967).

In an earlier paper (Soviet Phys.-JETP, 25:878(1967)) the author considered the Josephson effect with allowance for the quantum character of the interaction between the electrons and the electromagnetic field. It was shown that quantization leads to the appearance of a radiated-frequency band having a finite width; however, the width was not calculated. In this paper, the emitted-frequency band connected with the quantum fluctuations of the charge is calculated. (L.M.T.)

17587 BAND STRUCTURE AND SUPERCONDUCTIVITY OF NON-TRANSITION METALS. Havinga, E. E. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett., 26A: 244-6(Feb. 12, 1968).

It is shown that electrons in mixed O.P.W. wave functions are far more effective in causing superconductivity than electrons in single O.P.W.'s. Arguments given to support this statement are based on pseudo potential theory. Comparison is made with experimental facts. (auth)

17588 PRESSURE DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE. Olsen, J. L.; Andres, K.; Geballe, T. H. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Lett., 26A: 239-40(Feb. 12, 1968).

Published theoretical expressions are used to calculate the pressure dependence of the transition temperature in the non-transition metal superconductors. The experimentally observed effects can be approximately accounted for. (auth)

17589 COLLECTIVE TREATMENT OF LIQUID HELIUM. Gluck, P. (Univ. of Birmingham, Eng.). Phys. Lett., 26A: 230-1(Feb. 12, 1968).

A recently proposed collective approach to liquid ^{4}He is applied to ^{3}He. The effect of the different statistics is discussed. (auth)

17590 MIXED STATE OF THE TWO-BAND SUPERCONDUCTORS NEAR THE LOWER CRITICAL FIELD. Palistrant, M. E.; Moskalenco, V. A.; Dedju, V. I. (Mathematics Inst., Moscow). Phys. Lett., 26A: 196-7(Jan. 29, 1968).

Expressions are given and discussed for the energy density and the free energy of the filaments in the mixed state of a two-band superconductor. (auth)

17591 PROPOSAL OF CRUCIAL EXPERIMENTS FOR SUPERCONDUCTORS WITH INCOMPLETE INNER BANDS. Frohlich, H. (Univ. of Liverpool). Phys. Lett., 26A: 169-70 (Jan. 29, 1968).

Incomplete inner bands may provide a new acoustic branch and hence interelectronic interaction leading to superconductivity. Experiments to test this are proposed. Conditions for increasing transition temperatures are discussed. (auth)

17592 MICROWAVE-PHOTON-ASSISTED TUNNELING BETWEEN SUPERCONDUCTING TIN AND BULK NIOBIUM. Bonnet, D.; Rabenhorst, H. (Battelle Institut, Frankfurt am Main). Phys. Lett., 26A: 174-5(Jan. 29, 1968).

Photon-assisted tunneling between thin films of Sn and bulk Nb was observed under microwave radiation of 10 and 37 GHz. (auth)

17593 THERMAL CONDUCTIVITY OF SOLID ^{4}He AND OF ISOTOPIC MIXTURES AT HIGH DENSITIES. Berman, R.; Bounds, C. L.; Day, C. R.; Sample, H. H. (Oxford Univ.). Phys. Lett., 26A: 185-6(Jan. 29, 1968).

Conductivities have been measured at molar volumes down to 11.7 cm^3. Results for pure ^{4}He can be represented by a single reduced curve. The effect of adding ^{3}He is compared with a theory which takes account of lattice strains. (auth)

17594 PRESSURE DEPENDENCE OF THE ENERGY GAP OF SUPERCONDUCTING LEAD. Franck, J. P.; Keeler, W. J. (Univ. of Alberta, Edmonton). Phys. Rev. Lett., 20: 379-81 (Feb. 19, 1968).

The electron–phonon coupling strength in Pb, as measured by the "gap ratio" $2\Delta_0/kT_c$, decreases with increasing pressure. (auth)

17595 QUANTUM PHASE FLUCTUATIONS IN SUPERCONDUCTING TIN. Ulrich, B. T. (Ford Scientific Lab., Newport Beach, Calif.). Phys. Rev. Lett., 20: 381-4(Feb. 19, 1968).

Quantum phase fluctuations were observed at the onset of long-range quantum phase coherence in single-crystal bulk tin as it becomes superconducting. (auth)

17596 SUPERCONDUCTIVITY IN MULTIPLE PAIR-BREAKING REGIMES. Guertin, R. P.; Masker, W. E.; Mihalisin, T. W.; Groff, R. P.; Parks, R. D. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 20: 387-90(Feb. 19, 1968).

It is found experimentally that the thermodynamic behavior of superconductors in multiple pair-breaking regimes can be described by a particularly simple formalism due to Abrikosov and Gor'kov, and Fulde and Maki. (auth)

17597 SIZE EFFECT IN A GRANULAR SUPERCONDUCTOR. Parmenter, R. H. (Univ. of Arizona, Tucson). Phys. Rev., 166: 392-6(Feb. 10, 1968).

The superconducting energy gap and the transition temperature of a small grain of superconductor are larger than the corresponding quantities for bulk material. This results because the small dimensions cause a discrete, rather than continuous, spectrum of one-electron energy levels. This effect becomes important when the volume of the grain is comparable with, or smaller than, the characteristic volume $\lambda_F{}^2\xi_0$, where λ_F is the Fermi wavelength and ξ_0 the T = 0 Pippard coherence distance of the bulk material. As grain size is lowered, the ratio of T = 0 energy gap to Boltzmann's constant times transition temperature gradually increases from the weak-coupling limit (3.528) to the strong-coupling limit (4.0). (auth)

17598 EVIDENCE FOR A MIXED STATE IN A TYPE-I SUPERCONDUCTING FOIL IN A TRANSVERSE MAGNETIC FIELD. Cape, J. A. (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Rev., 166: 432-6(Feb. 10, 1968).

Resistance and magnetization measurements have been carried out as a function of temperature, applied field, and transport current (resistance only) on a series of dilute In–Bi alloy foils ($0.45 < \kappa_1 < 0.75$, thickness $d \geq 0.002$ cm). The data enable the determination of H_{c2}, H_{cB}, $\kappa_1(T)$, and $\kappa_2(T)$ over most of the superconducting temperature range ($t \gtrsim 0.3$). It is found that In–1.25 at. % Bi [$\kappa_1(T_c) \approx 0.64$], and In–1.15 at. % Bi [$\kappa(T_c) \approx 0.62$]—both of which are bulk type-II superconductors at temperatures well below T_c—exhibit mixed-state-like behavior as foils in a transverse applied field at all temperatures below T_c. Specifically, at thicknesses less than approximately 0.005 cm, the transverse-field magnetization exhibits an apparent second-order transition at $H_{c2} < H_{c3}$, the parallel transition field. The H_{c2} (T) and κ_1 (T) values thus determined are in good agreement with the dirty-limit-theory temperature dependence. Moreover, the κ_2(T) values which are determined from the slope of the transverse-field magnetization by the formula $-4\pi M = (H_{c2} - H_0)/[(2\kappa_2^2 - 1)\beta + 1]$ are in good agreement with the κ_1 values near T_c and exhibit similar temperature dependence. It is found that the critical fields of the magnetization curves can be identified with characteristic features of the resistive transition curves. (auth)

17599 FLUX-TRANSPORT NOISE IN TYPE-II SUPERCONDUCTORS. van Gurp, G. J. (N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Rev., 166: 436-46 (Feb. 10, 1968).

The transport of magnetic flux in type-II superconductors under the influence of a transport current is shown to give rise to a noise voltage superposed on the dc voltage. This flux-flow noise is analogous to shot noise limited by transit-time effects, and is caused by the motion of discrete units of flux between the edges of the superconductor. If the flux is in a circular motion so that no transit of flux between the edges takes place, no flux-flow noise can be detected. It is shown from measurements of the frequency spectrum of the noise voltage in vanadium foils that the dc voltage is built up of voltage pulses generated during flux motion, whose duration is equal to the transit time of the flux units. Because of interaction with pinning centers, a fraction of the flux does not take part in the motion. This fraction is found to increase with decreasing temperature and current. It increases with magnetic field in cold-rolled vanadium that exhibits a resistance minimum, but decreases with field in annealed vanadium, where such a minimum is not present. The moving flux units are bundles of flux lines. The average number of flux quanta in a bundle depends on pinning conditions, as is shown for vanadium foils and an indium–thallium crystal. This number decreases with increasing temperature, current, and magnetic field. It is also found to fluctuate owing to interaction with the pinned fraction. At high fields and currents, flux transport in annealed material is in the form of single flux quanta. When the power dissipation in the specimen is increased, a noise voltage with approximately $1/f^b$ frequency dependence is found, with $2 < b < 3$. This "flicker noise" is shown to be generated by temperature fluctuations in the foil. These fluctuations are caused by nucleate boiling of liquid helium, and they virtually disappear below the helium λ point. Some flicker noise is left there, due to pressure variations above the liquid. (auth)

17600 MODIFIED LONDON MODEL FOR TYPE-II SUPERCONDUCTORS. Coffey, H. T. (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 166: 447-56(Feb. 10, 1968).

A model is presented which modifies the London theory of superconductivity by incorporating solutions of the theory which are usually omitted owing to an infinity at the coordinate axis. These solutions are retained by limiting the current density to the finite critical current density previously calculated by London. The resulting radius at which this value is attained is assumed to be a constant, independent of field, and is related to the coherence distance of the Ginzburg-Landau theory. A circular boundary condition is then employed such that on the boundary the current density vanishes, and the interior of the circle contains one flux quantum. The radius of this circle is field-dependent, leading to the condition that the entire flux quantum is contained as magnetic flux in the normal core when the bounding radius equals that of the fluxoid core. At this field the current density vanishes, defining the upper critical field H_{c2}. The Gibbs energy is then constructed and used to calculate the applied field and magnetization. From this calculation, a simple but rather accurate expression for the lower critical field H_{c1} is obtained. Considerations of the condensation energy lost in the normal core and in an assumed microscopic hole in the superconductor show that the energy is lower when a fluxoid is located over the hole so that the fluxoid is pinned; one can also make an approximate calculation of the transport current density. (auth)

17601 ISOTOPE EFFECT IN SUPERCONDUCTING RHENIUM. Maxwell, E. (Massachusetts Inst. of Tech., Cambridge); Strongin, Myron; Reed, T. B. Phys. Rev., 166: 457-8(Feb. 10, 1968). (BNL-11777).

The isotope shift in superconducting rhenium has been measured. The parameter ζ, measuring the deviation from the full BCS exponent of $\frac{1}{2}$, is 0.288 ± 0.034. (auth)

17602 THERMODYNAMICS OF VOLUME AND PRESSURE EFFECTS FOR TYPE-II SUPERCONDUCTORS. Hake, R. R. (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Rev., 166: 471-5(Feb. 10, 1968).

Some thermodynamic relationships which include volume and pressure effects are presented for the case of the ideal bulk type-II superconductor. On the basis of published data, it is assumed that the upper-critical-field transition at (H_{c2}, T_s) occurs without discontinuities in the entropy and magnetization and without infinite discontinuities in the second-order derivatives of the Gibbs free energy. For an ellipsoidal specimen in an applied field H directed along a principal axis at (H_{c2}, T_s), Clapeyron- and Ehrenfest-type equations yield $\Delta V = 0$, $\Delta K = (S_0/4\pi V)(\partial H_{c2}/\partial P)_T^2$, and $\Delta\beta = (-S_0/4\pi V)(\partial H_{c2}/\partial P)_T(\partial H_{c2}/\partial T)_P$. Here Δ indicates the difference between the superconducting- and normal-state values at constant H; V is the specimen volume (which is shown to be field-dependent in the superconducting type-II mixed state); $K = -V^{-1}(\partial V/\partial P)_{H,T}$ is the isothermal compressibility; $\beta \equiv V^{-1}(\partial V/\partial T)_{H,P}$ is the thermal expansivity; and $S_0 \equiv \{\partial[4\pi(I_s - I_n)]/\partial H\}_{P,T}$, where I_s and I_n are the total superconducting- and normal-state magnetic moments and the derivative is taken at (H_{c2}, T_s). (auth)

17603 ULTRASONIC STUDIES OF THE SUPERCONDUCTIVITY OF DOPED TIN. II. Claiborne, L. T.; Einspruch, N. G. (Texas Instruments Inc., Dallas). Phys. Rev., 166: 476-8(Feb. 10, 1968).

Recent ultrasonic-attenuation studies have led to conflicting interpretations concerning the reduced anisotropy of the superconducting energy gap characteristic of impure Sn. Perz and Dobbs have concluded that the reduced anisotropy is only due to an averaging of the electron–sound-wave interaction over the Fermi surface, while we have concluded that under the specified conditions the reduced anisotropy is indeed a real measure of the superconducting properties. The two conclusions are discussed in detail, and additional ultrasonic data are presented. Finally, comparison is made with recent thermal-conductivity measurements in impure Sn. (auth)

17604 SPECIFIC HEAT OF NIOBIUM–TIN. Vieland, L. J.; Wicklund, A. W. (RCA Labs., Princeton, N. J.). Contract AF33(615)3936. Phys. Rev., 166: 424-31(Feb. 10, 1968).

The specific heat of Nb_3Sn has been measured over the temperature range 1 to 42°K, and in magnetic fields up to 52.5 kG. The data can be interpreted to give $\gamma = 13.1$ mJ/g atom °K², $\Delta C/\gamma T_c = 2.4$, $H_0 = 5350$ G, and $\kappa(T_c) = 21.7$. The Debye temperature θ appears to increase at the rate of 1°K/°K over most of the range of the measurements, with $\theta(0) = 228$°K. Measurements have also been made on a sample of composition Nb_4Sn, and on vapor-grown Nb_3Sn similar to that exhibiting the cubic-tetragonal lattice transformation. The specific heat of Nb_3Sn can be reconciled with elastic-constant data only if it is assumed that the lattice softening implied by the decreasing velocity of sound with decreasing temperatures is limited to frequencies considerably below the Debye frequency. (auth)

17605 FLUX QUANTIZATION AND DIMENSIONALITY. Bloch, F. (Stanford Univ., Calif.). Phys. Rev., 166: 415-23 (Feb. 10, 1968).

A system of charged particles in a ring of radius R is considered, assuming separability of the tangential component of the total momentum. The dependence of the free energy upon the magnetic flux through the ring is shown to be strongly affected by the dimensionality. Irrespective of the specific dynamical properties of the system, one finds in the one-dimensional case that a realistic choice of R leads to the exclusion of thermodynamically stable flux trapping. The entirely different criterion for the three-dimensional case is separately discussed and is seen to be closely related to the mean-square fluctuation of the total momentum. (auth)

17606 FLUX QUANTIZATION IN A ONE-DIMENSIONAL MODEL. Schick, Michael (Stanford Univ., Calif.). Contract NONR-225(75). Phys. Rev., 166: 404-14(Feb. 10, 1968).

A one-dimensional model of interacting electrons is studied to determine whether such a system, in thermal equilibrium, can exhibit flux quantization. The free energy and current of the system are calculated and shown to be periodic functions of the flux enclosed in a ring-shaped sample with period hc/e. The Maxwell equations provide a second relation between the current and flux. It is found that at finite temperatures, the equations for the current I and the flux Φ_B have only the trivial solution $I = \Phi_B = 0$ in the limit of macroscopic systems. Therefore, there is no flux quantization. The free energy is calculated by a generalization of the method of Tomonaga. This method describes the Fermi system in terms of an equivalent set of bosons which represent the collective modes of the Fermi gas. The major results of the generalization are the appearance of trilinear terms in the equivalent boson Hamiltonian and effects of a vector potential. (auth)

17607 ANISOTROPY OF THE COUNTERFLOW OF LIQUID HELIUM II PAST A FLAT PLATE. Le Ray, M.; Bataille, J.

(Laboratoire de Mecanique des Fluides, Orsay, France). Phys. Lett., 26A: 283-4(Feb. 26, 1968).

It is shown experimentally that the normal flow plays a key role in the orientation of superfluid vortices. A tentative explanation is given. (auth)

Plasma and Thermonuclear Physics

17608 (NP-17283) BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF GASES AND PLASMAS. No. 25. Brewer, L. (comp.) (California Univ., Berkeley. International Union of Pure and Applied Chemistry. Commission on High Temperatures and Refractories). Dec. 31, 1967. 46p. NBS, Washington, D. C. Free.

A listing of 181 papers on high-temperature chemistry and physics of gases and plasmas is presented. (M.O.W.)

Confinement and Heating of Plasma

17609 (GA-8141) PLASMA CONFINEMENT IN GENERAL ATOMIC TOROIDAL OCTOPOLE. Yoshikawa, Masaji; Ohkawa, Tihiro; Schupp, Arthur A. (Gulf General Atomic, Inc., San Diego, Calif.). June 14, 1967. 30p. Dep. CFSTI.

Plasma confinement in the toroidal octopole device is described. The octopole field is produced by four current-carrying rings which are held by supporting rods. A toroidal field may also be applied. The plasma is injected from a coaxial gun. The density is variable from 10^8 to 10^{13} cm^{-3} and the ion and electron temperatures are approximately 100 eV and 6 eV, respectively. Measurements are performed by neutral and ion analyzers and electrostatic and magnetic probes. The ion confinement time depends on the plasma density. At densities higher than 10^{11} cm^{-3}, the high-energy ions are lost in tens of microseconds by charge-exchange interaction with the gas released by plasma bombardment near the injection window. For the plasma with densities below 10^{11} cm^{-3}, the ion confinement time is several hundreds of microseconds at 100 eV. The decay is consistent with the loss on the supporting rods. The decay rate is orders of magnitude less than the rate estimated from the fluctuation amplitudes in the plasma and at least an order of magnitude less than predicted from the Bohm diffusion coefficient. (auth)

17610 (INR-P-850/XVIII/PP) EXPERIMENTAL STUDIES OF A COAXIAL PLASMA INJECTOR. I. STUDY OF OPERATIONAL CONDITIONS. Sadowski, Marek; Skladnik-Sadowska, Elzbieta (Institute of Nuclear Research, Warsaw (Poland)). 1967. 23p. Dep.

Investigations were made on the optimization of the parameters and operational conditions of a coaxial plasma injector. A detailed description of the experimental system is given, and the results of measurements performed by means of magnetic probes and a high-speed camera are discussed. The velocities of plasmoids emitted are determined and the regime of efficient operation of the injector is established. (auth)

17611 (INR-P-861/XVIII/PP) INVESTIGATIONS OF GAS-CONDITIONS IN THE OPERATION OF A COAXIAL PLASMA INJECTOR. Kozlowski, Zbigniew; Sadowski, Marek (Institute of Nuclear Research, Warsaw (Poland)). 1967. 35p. Dep.

An analysis was made of the composition of residual gas in the experimental chamber under stationary conditions. Examined also are variations in gas composition and partial pressures following the operation of a fast gas valve, as such are due to the discharge process in the plasma injector. It is established that the basic sources of plasma impurities are the processes of gas desorption from the walls of the experimental chamber, as well as the decomposition of heavy particles of oil vapors penetrating from the vacuum pumps. The propagation velocities of the working-gas puff admitted into the injector and the pressure-time characteristics are also determined. It is further established that, during the plasma generating discharge, there occurs a sorption activation of walls and an exchange of gases between the plasma and a fraction of the internal surfaces of the system. (auth)

17612 (MATT-Trans-50) PULSED THERMONUCLEAR SYSTEM WITH A DENSE PLASMA. Alikhanov, S. G.; Kichigin, G. N.; Konkashbaev, I. K. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated for Princeton Univ., N. J., from a Russian Report. 19p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

An investigation was made of a closed system which is convenient for adiabatic compression of a dense plasma by jacket deformation. It is shown that the system is in equilibrium and magnetohydrodynamically stable for the required time. A sufficient rate of compression and the brief period of operation of the system offer the possibility of neglecting the relatively slow losses of plasma as a result of diffusion with a Böhm order coefficient. (auth)

17613 THE TOROIDAL WEAKLY IONIZED MAGNETOPLASMA. I. Karger, F. (Institut fuer Plasmaphysik, Munich). Z. Naturforsch., 22A: 1890-4(Dec. 1967). (In German).

In a previous paper (F. Karger, Z. Naturforsch., 22a: 1039 (1967)) discrepancies between theory and experiment were found on investigating the positive column in a curved magnetic field. The approximation derived by Karger for the torus drift in a weakly ionized magnetoplasma is checked here with a refined theory which also yields the transverse electric field strength. Experimentally, both the transverse electric fields and the density profiles in the dc discharge were determined in addition to the longitudinal electric field strength. The discrepancies are ascribed to the fact that the plasma concentrates at the cathode end of the magnetic field coils, this effect having a considerable influence on the form of the transverse density profile and on the stability behavior. (auth)

17614 THE TOROIDAL WEAKLY IONIZED MAGNETOPLASMA. II. Karger, F. (Institut fuer Plasmaphysik, Munich). Z. Naturforsch., 22A: 1904-19(Dec. 1967). (In German).

A special alternating field method was used to eliminate the influence of the concentration effect on the measurements of interest and to increase by more than an order of magnitude the critical magnetic field strength for the onset of the helical instability of the positive column. This made it possible to check in detail the theory of a stable, weakly ionized toroidal magnetoplasma (potential profile, density profile, charge carrier losses). The theoretically predicted transverse electric field strength leading to the torus drift was observed, while the outward density displacement due to the torus drift did not occur. It was proved that the reason for this was an effect which results from a transverse gradient in the rate of ionization (grad ξ effect) and which causes a substantial reduction of the charge carrier losses. In the decaying plasma with vanishing longitudinal electric field, on the other hand, the outward density displacement was recorded in accordance with the theory. The influence of the toroidal curvature on the magnetic field strength at which the helical instability sets in and on the turbulent state of the positive column was also investigated. It was also possible to verify the influence of the grad ξ effect on the helical oscillation. The grad ξ effect may be important for the early heating phase in projected toroidal fusion machines with neutral gas stabilization. (auth)

17615 CUSP INJECTION EXPERIMENT. Nakano, Yoshiei; Hirano, Katsumi (Tokyo Inst. of Tech.). Denki Gakkai Zasshi, 87-6: 1243-51(June 1967). (In Japanese).

A study was carried out on the containment in a magnetic field vessel of the plasma produced from a plasma gun. For the case of the plasma injection from a point cusp on one side alone, and also for the case of the simultaneous plasma injections from point cusps on both sides, the injection phenomenon, and the behavior of a plasma in the cusped magnetic field were examined by the use of a magnetic probe, an electrostatic probe, a Kerr-cell camera, etc.; a comparison was made between the two cases. When injected from point cusps on both sides, the axial movement of the plasmas are blocked, and a region where β(plasma/magnetic field) = 1 is formed in the middle of the cusp vessel for about 10μs. And, even when $\beta < 1$ at the point cusps at the time of injections, $\beta = 1$ in the middle of the vessel. When injected from a single plasma gun alone, on the other hand, these phenomena do not occur. When the magnetic field is weak, the plasma is injected through a path formed by the displacement of magnetic field, flowing out through the point cusp on the opposite side. In the high-intensity magnetic field, the plasma is injected in the form of a beam without deforming the magnetic field. (NSA of Japan)

17616 ASPECTS OF COLLISIONAL DIFFUSION TRANSVERSE TO A STABLE MAGNETIC PLASMA. Weinstock, Jerome (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Phys. Fluids, 11: 354-7(Feb. 1968).

An autocorrelation function method is given which permits one to treat, in a relatively simple and concise manner, some aspects of transverse diffusion in stable plasmas that are generally omitted or difficult to formulate by other methods. An expression for the transverse diffusion coefficient is thereby obtained which is valid under a wide set of circumstances including non-Maxwellian, but stable, velocity distributions, arbitrary ratio of gyrofrequency to collision frequency, and weakly nongyrotropic velocity distributions. It is also emphasized that the diffusion coefficient is not simply an eigenfunction of the collision operator, and the correction factors are explicitly given for magnetic non-Maxwellian plasmas. (auth)

17617 TURBULENT DIFFUSION EXPERIMENTS IN A THERMAL PLASMA. Porkolab, M.; Kino, G. S. (Stanford Univ., Calif.). Phys. Fluids, 11: 346-53(Feb. 1968).

Results of a detailed experimental study of turbulent diffusion are presented. The turbulent state is produced in a thermal potassium plasma by (i) injected coherent signals and (ii) injected broad-band noise. Diffusion is found to be directly proportional to the rms amplitude of oscillations, and inversely proportional to the magnetic field intensity. The effect of the oscillation spectrum upon diffusion is also studied. Finally, using the relation $eV_{rms} = kT$ in a Bohm-type diffusion coefficient, numerical estimates are made with the Bohm diffusion coefficient. (auth)

17618 PLASMA LOSSES IN A TOROIDAL MAGNETIC FIELD. Mah, S. Q.; Skarsgard, H. M. (Univ. of Saskatchewan, Saskatoon). Phys. Fluids, 11: 423-4(Feb. 1968).

Plasma losses in a toroidal low-pressure rf discharge have been studied by comparing measured electron temperatures with those predicted by the plasma balance equation. The losses can be attributed to the drift of the partially ionized plasma across the inhomogeneous magnetic field. (auth)

17619 STRONG NEGATIVE-V'' TORUS. Furth, Harold P. (Princeton Univ., N. J.); Hartman, Charles W. Phys. Fluids, 11: 408-10(Feb. 1968).

The restriction of helical stellarator windings to the large-major-radius side of the torus minor circumference, combined with the use of an axisymmetric poloidal field, gives markedly improved negative-V'' properties. (auth)

17620 QUASILINEAR THEORY OF CHERENKOV PLASMA HEATING. Dolgopolov, V. V.; Sizonenko, V. L. (Physical-Technical Inst., Kharkov). Nucl. Fusion, 7: 177-84(Dec. 1967).

Cherenkov heating was investigated in a radially nonuniform plasma cylinder, taking into account the effect of oscillations on the background charged particle distribution function. Equations are derived for particle diffusion in velocity space which are valid for both narrow and broad wave packets, and also for the energy absorbed by the plasma. The effect of collisions is taken into account. The energy gained per unit time by an ion is estimated for the case of broad wave packets, when the background distribution function is non-Maxwellian to an insignificant extent. It is shown that in the case of narrow wave packets, when the coefficient of diffusion in velocity space (characterizing the effect of oscillations on the background distribution function) exceeds the coefficient of diffusion due to collisions, "absorption saturation" ensues and an increase in the amplitude of the electromagnetic field does not lead to an increase in absorbed energy. It is also shown that heating with narrow wave packets is no less effective than heating with broad wave packets, provided that the background distribution function in the latter case is not significantly non-Maxwellian. (auth)

17621 LIFETIME OF INDIVIDUAL CHARGED PARTICLES IN A MAGNETIC MIRROR TRAP. Balebanov, V. M.; Semashko, N. N. (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 7: 207-18(Dec. 1967).

The lifetime of individual charged particles (electrons) was measured in a steady-state, axially symmetric magnetic mirror trap under certain definite particle injection conditions. The experiments confirmed that, when the particles were reflected from the mirrors, the change in magnetic moment $\Delta\mu/\mu$ relative to the adiabaticity parameter was exponentially small. In the expression for $\Delta\mu/\mu$, the exponent and the pre-exponential factor were found for an actual Ogra field configuration. Under conditions corresponding to absolute containment of the particles in the trap a marked increase in electron lifetime was observed. An expression was obtained for the change in the magnetic moment of a charged particle passing through a small magnetic field perturbation. The experimental results were found to be in satisfactory agreement with those obtained using this expression. (auth)

17622 SOME ENGINEERING PROBLEMS OF THERMONUCLEAR REACTORS. Mills, R. G. (Princeton Univ., N. J.). Nucl. Fusion, 7: 223-36(Dec. 1967).

The features of a hypothetical controlled thermonuclear reactor that today seem most crucial to its performance are considered: the plasma, the vacuum magnetic field, the divertor, the vacuum wall, the energy absorbing blanket and the current-carrying coils. Some of the conditions necessary for a successful reactor are discussed. On the basis of the present limited knowledge of the essentials for a nuclear fusion power plant, a model is selected and its economics examined. It may be concluded that, if the fundamental problem of plasma confinement can be solved and several technological requirements met, fusion power stations should be economically successful. (auth)

17623 METHOD FOR INTRODUCING ENERGY SPREAD INTO PLASMAS FORMED BY HIGH-ENERGY NEUTRAL INJECTION. Colchin, R. J.; Dunlap, J. L.; Edwards, R. S.; Postma, H. (Oak Ridge National Lab., Tenn.). Nucl. Fusion, 7: 292-3(Dec. 1967).

A technique is reported for rapidly modulating the energy of a fast neutral particle beam and thereby introducing energy spread into plasmas formed in magnetic traps by high-energy neutral injection. (M.O.W.)

17624 FIELD OF THE TETRAHEDRAL SPIRE AS A MAGNETIC WELL. Boyd, D. A.; Cilliers, W. A.; Driver, H. S. T. (Univ. of Cape Town). Nucl. Fusion, 7: 290-2(Dec. 1967).

The results of field measurements over an extended volume inside the spire are presented. (M.O.W.)

17625 ACCELERATION OF A DENSE JET TO THERMONUCLEAR VELOCITIES BY HYPERVELOCITY IMPACT. Winterberg, F. (Univ. of Nevada, Reno). Nucl. Fusion, 7: 289-90(Dec. 1967).

Two methods of acceleration are briefly discussed: first, the acceleration of solid particles by electrostatic accelerators; and secondly, the magnetic acceleration of a superconductor by a traveling magnetic wave. (M.O.W.)

17626 DESTRUCTION OF MAGNETIC SURFACES BY MAGNETIC FIELD IRREGULARITIES. PART II. Filonenko, N. N.; Sagdeev, R. Z.; Zaslavskii, G. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Nucl. Fusion, 7: 253-66(Dec. 1967).

Problems associated with the condition for the existence of magnetic surfaces in closed systems of the stellarator type are discussed. The unperturbed geometry of the magnetic field is produced by a straight helical field. Exact equations for the motion of the magnetic field lines are put into Hamiltonian form and action-phase variables are introduced. The effect on magnetic field geometry of a perturbation that is periodic with respect to the coordinate along the toroidal axis is studied. It is shown that, if the perturbation is greater than some critical value, the motion of those field lines that are at a sufficient distance from the toroidal axis is similar to Brownian motion and leads to the destruction of the magnetic surfaces. The explicit form of the condition for stochastic instability of the magnetic field lines is derived and the coefficient of field line diffusion from the volume is estimated. With the above method it is possible to consider the most important form of perturbation in stellarator systems occurring when the cylindrical, helical field is bent into a torus. Irrespective of the magnitude of the correction for the toroidality of the geometry, destruction of the magnetic surfaces occurs near the separatrix of the unperturbed magnetic field, and this effectively reduces the region bounded by the separatrix of the perturbed field. When the toroidal perturbations are small, the destruction is of a stochastic nature. It follows from the estimate made of the region where destruction takes place that the maximum shear permissible in toroidal systems is substantially limited. Computer calculation results illustrating the stochastic nature of the destruction of the magnetic surfaces are given. (auth)

17627 STOCHASTIC ACCELERATION IN A MAGNETIC MIRROR. Puri, S. (Stanford Univ., Calif.). Phys. Lett., 26A: 193-4(Jan. 29, 1968).

Statistical acceleration rate of a charged particle in a magnetic mirror is derived, correct within a factor of two, for the case when the electric field spectrum spans the spectrum of mirror gyrofrequencies. (auth)

17628 PARTICLE LOSSES DUE TO CHARGE EXCHANGE IN CESIUM PLASMAS. Dreicer, Harry; Henderson, Dale B. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett., 20: 374-8 (Feb. 19, 1968). (LA-DC-9296).

The charge-exchange cross section for cesium ions moving in their own vapor has been analyzed and found sufficiently large to influence particle loss measurements made on Q-machine plasmas. (auth)

17629 THEORY OF RELATIVISTIC PLASMA HEATING BY STOCHASTIC FIELDS. Indykul, V. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 1941-5(Dec. 1967). (In Russian).

The interaction is considered of a relativistic plasma with stochastic oscillations, finiteness of the correlation time of

Fourier components of the field being taken into account. The effect of random fields on the plasma is considered in quasilinear approximation. It is shown that for the plasma in an external magnetic field the interaction with a stochastic field results in the diffusion of plasma particles in an impulse space and in establishing a plateau on the particle distribution functions. An expression is obtained for the established distribution function in cases when wave phase velocity is less than light velocity. Otherwise, expressions are obtained for measuring with an average transverse impulse time and temperature. Ratios are also obtained for averaged characteristics of the plasma interacting with longitudinal oscillations. An average directed impulse and temperature in an ultrarelativistic case grow with time as $t^{½}$. (auth)

Diagnostics of Plasma

17630 (CEA-R-3125) ETUDE DES PROPRIETES DES PLASMAS DENSES AU MOYEN D'ONDES ELECTROMAGNETIQUES DE TRES HAUTE FREQUENCE (ONDES LUMINEUSES). (Study of Dense-Plasma Properties Using Very High-Frequency Electromagnetic Waves (Light Waves)). Gormezano, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 136p. (In French). Dep. Thesis. Submitted to Univ., Paris.

A study is made of methods based on the following use of lasers for measuring the electronic density and temperature of dense plasmas ($N_e > 10^{15}$ e/cm^3): an interferometric method using a gas laser, based on the properties of the Perot-Fabry cavities; and a method making use of the 90° scattering produced by the plasma on light emitted by a ruby laser. These methods have been applied to various dense plasmas: high-frequency plasma torch, azimuth compression, and plasma bursts produced by focusing a laser beam on a metal target. The measurements have also been carried out using conventional methods of diagnosis. It has thus been possible to measure densities of between 5×10^{15} and 10^{18} e/cm^3 and temperatures of between 3 and 10 eV. These different methods are then compared. (auth)

17631 (INR-P-851/XVIII/PP) EXPERIMENTAL STUDIES OF A COAXIAL PLASMA INJECTOR. II. PROBE MEASUREMENTS OF ELECTRON TEMPERATURE. Sadowski, Marek; Skladnik-Sadowska, Elzbieta (Institute of Nuclear Research, Warsaw (Poland)). 1967. 19p. Dep.

In order to determine the conductivity and electron temperature of plasma generated by the coaxial injector, a detailed analysis of diamagnetic signals from plasmoids injected into a uniform magnetic field was performed. For purposes of comparison, a number of measurements were made by means of a double Langmuir probe for the case without the external magnetic field, and in the space beyond the diagnostic field. (auth)

17632 REFRACTIVE METHODS USED IN LABORATORY PLASMA. Martellucci, S. (EURATOM-CNEN, Rome). Nuovo Cim. (1), Suppl., 5: 642-79(1967).

The various refractory methods for plasma diagnostics are discussed. These include interferometric measurements, Schlieren photography, shadowgraph photography, and Faraday-rotation measurements. (M.O.W.)

17633 DETERMINATION OF RADIAL TEMPERATURE DISTRIBUTION IN ARGON-HYDROGEN PLASMA JET. Terasawa, Yoshio (Hitachi Ltd., Japan). Jap. J. Appl. Phys., 6: 1326-8(Nov. 1967).

In the case when the plasma temperature is below the calibrating temperature required in the Fowler-Milne method, a new method for determining the radial temperature distribution in an $Ar-H_2$ gas mixture plasma jet is described. It is shown that the radial temperature distribution can be determined by combining the radial intensity distribution for the λ4200 Ar I line and the Stark profile for the Hβ line. This method requires only measurement of the relative intensity for a spectral line. (auth)

17634 STUDY BY CALORIMETRIC METHODS OF A HIGH-FREQUENCY DISCHARGE IN ARGON AT ATMOSPHERIC PRESSURE. Besombes-Vailhe, Jean (Faculte des Sciences, Toulouse. Institut du Genie Chimique, Toulouse). Rev. Phys. Appl., Suppl. J. Phys., 2: 225-34(Dec. 1967). (In French).

The power developed in the jet of a high-frequency plasma torch (6.7 MHz) at atmospheric pressure was studied. The recoverable power in the inductor in the form of heat, the thermal power evolved by the discharge and, lastly, the radiated power in the spectral range of 4500 to 6500 Å were measured by calorimetric methods. The average calorimetric temperature of the discharge gases is calculated, and it is shown that its value is much below (30%) that of the plasma determined by spectral methods. In this case, and by applying the Saha equation, it follows that the continuous radiated power by an argon plasma atom is a function of its temperature only. (auth)

17635 TEMPERATURE DISTRIBUTION IN AN ARGON PLASMA JET. Takahashi, Takeshige; Nakashio, Fumiyuki (Kyushu Univ., Japan) Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku, No. 46, 1-9(Dec. 1967). (In Japanese).

The temperature distributions in an argon plasma jet were investigated by using the spectroscopic method. The wave length of the argon line spectrum used was 4,158.59 Å (Ar I) and the intensity distributions of this line spectrum in the plasma jet was measured by the photographic method under several operating conditions of the current and the operating gas flow rate ranging from 200 to 350 A and 20 to 35 l/min respectively. The temperature distributions were calculated from these intensity distributions adopting Lorentz's treatments, and the results obtained did not show any appreciable change in the operating conditions. It is shown that the temperature of the plasma jet in the reactor attached to the plasma gun became lower than that of the plasma jet in an open space and went down further with the increase of the rate of argon fed in place of reactant gas into the reactor through the small hole. (NSA of Japan)

17636 MEASUREMENT OF THE ELECTRICAL CONDUCTIVITY OF SEEDED FLAME PLASMAS. Koyama, Kenichi; Sekiguchi, Tadashi (Tokyo Univ.). Denki Gakkai Zasshi, 87-6: 153-9(June 1967). (In Japanese).

The method of measuring the electrical conductivity of a seeded flame plasma without disturbing the flame has been developed in which microwaves (75 Gc) and high-frequency waves (10 Mc) are employed. With this method, the electrical conductivities of the potassium-seeded and the oxide-powder-seeded flame plasmas were measured. The potassium was shown to give the largest electrical conductivity. The method developed is also applicable for a burning gas of a high temperature (2,500 to 3,000°K) for the MHD power generation, without the problems in the conventional electrode method such as the damage of the electrode. The electrical conductivity of plasmas are theoretically discussed, and also the various seeding materials are compared. (NSA of Japan)

Kinetics of Plasma

Refer also to abstracts 17311, 17344, and 17436.

17637 (IAE-1244) ELEKTRONNYE TSIKLOTRONNYE VOLNY V PLAZMENNOM VOLNOVODE. (Electron Cyclotron Waves in the Plasma Waveguide). Patrushev, B. I.; Gozak, V. P.; Frank-Kamenetskii, D. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 32p. (In Russian). Dep.

Experimental investigation of the distribution of electron cyclotron waves in plasma along a magnetic field in a magnetic mirror system is reported. The spatial distribution and alternating field distribution of the wave was measured with a magnetic probe. The aspects studied included penetration of the uhf wave into plasma, ionization and heating of plasma upon injection of neutral gas, heating of injected plasma, x radiation of plasma, spatial concentration distribution, effect of probes, particle and energy lifetimes, and the apparent and real resonance width. It was shown that the wave concentrates in the waveguide. The most efficient energy absorption and electron heating occur under the conditions of cyclotron resonance in the inhomogeneous magnetic field domain. Electron temperatures of several hundred eV were attained at electron concentrations of the order of 5×10^{11} cm^{-3}. To explain the observed processes of the uhf wave interaction, a working hypothesis envisages that, as a result of collective interactions, the wave entering the plasma is transformed into noise with an expanded and displaced spectrum and directionally uniform field distribution. (JPRS)

17638 MEASUREMENTS OF MEAN FREE PATH AND DRIFT VELOCITY OF ELECTRONS. Yoseli, Morihiro; Kosuge, Noriyoshi (Electrotechnical Lab., Tokyo). Denki Shikensho Iho, 31: 1109-15(Oct. 1967). (In Japanese).

The mean free path and drift velocity of electrons in a plasma stream have been measured by a probe method with the plane probe changing the direction of its exposed face. The single and double probes are used for the measurements of the mean free path and drift velocity of electrons, respectively. The measurements are made in the mercury vapor plasma drifted from the mesh anode to a reflector, where the electron density is about 5×10^{9} cm^{-3} and the electron temperature is about 4×10^{4}°K, and they give the mean free path of 13 cm and the drift velocity of 2.1×10^{8} cm/sec at 15°C. The measured results of the mean free path agree with those measured by the Brode method. Effects of the drift velocity on the probe are qualitatively explained by a theory developed from Johnson–Malter theory for the electrons with the drifted Maxwellian velocity distribution. (NSA of Japan)

17639 EFFECTIVE DIELECTRIC TENSOR AND PROPAGATION CONSTANT OF PLANE WAVES IN A RANDOM ANISOTROPIC MEDIUM. Liu, C. H. (Univ. of Illinois, Urbana). J. Math. Phys. (N.Y.), 8: 2236-42(Nov. 1967).

Random anisotropic media are assumed to be characterized by dielectric tensors in which the components are random functions of position. A turbulent plasma in a static magnetic field is one example of such media. In this paper wave propagation in turbulent magnetoactive plasma is studied. The averages of electric field and dielectric displacement vectors over an ensemble of these media are found, assuming these average quantities are time-harmonic plane waves. The effective dielectric tensor is defined as the proportionality factor between the two average quantities. When this effective dielectric tensor is applied to the wave equation, a general dispersion relation for plane waves is derived. Expressions for propagation constants are obtained and some special cases are considered in detail. It is found that, because of random scattering, there are attenuations for both the ordinary and extraordinary waves for the average fields. The results reduce to those obtained by Keller and Karal when the anisotropy of the background media is removed. (auth)

17640 PROPAGATION AND COUPLING OF WAVES IN INHOMOGENEOUS MEDIA. Rydbeck, O. E. H. (Chalmers Univ. of Tech., Gothenberg, Sweden). Ark. Fys., 33: 533-92 (1967).

Stationary magnetoionic media represent typical 4-wave systems, and the traveling-wave tube represents a typical 3-wave system in the first-order approximation. The ordinary inhomogeneous isotropic medium is classified as a 2-wave system. Many electronic devices, such as the plasma amplifier, are multiwave structures. In many physical systems a number of different waves may be present at the same time—electromagnetic waves, space charge waves, cyclotron waves, sound waves, etc. The wave coupling depends both upon the physical nature of the waves involved and the rate of change of the characteristic parameters of the system. Usually, the interaction of such waves is a very complex phenomenon, sometimes resulting in a strong coupling. A space charge wave may be almost completely transformed to an electromagnetic wave, or vice versa. Firstly, it was the object to apply the coupling methods to the 2-wave system, and secondly, to extend these methods to an arbitrary n-wave system. It was proved that this can be done in a practically useful way, which permits a rapid first-order study of complex systems. The usefulness of the developed methods depends upon the fact that when two waves interact strongly in one region of the system, the others often are only moderately perturbed. This basic study leads to an expression for, and a physical explanation of, the general amplitude coefficients of the n-wave systems, together with intensity and energy flow relations. The general methods derived will be a useful tool on problems of complex wave propagations in multi-anisotropic media. A number of applications to electromagnetic and space charge waves is included. (auth) (Sweden)

17641 EFFECT OF SECOND-ORDER TERMS ON THE SECOND HARMONIC AND SUM AND DIFFERENCE FREQUENCY GENERATION IN AN INHOMOGENEOUS PLASMA. Gupta, G. P. (Indian Inst. of Tech., New Delhi). Proc. Phys. Soc. (London), 92: 1122-33(Dec. 1967).

Expressions for the second harmonic and sum-and-difference frequency components of the current density in a plasma (due to two alternating electric fields, an electron density gradient and a temperature gradient) derived by earlier workers have been modified to incorporate the effect of the higher-order asymmetrical term f_2 in the expansion of the distribution function. The normalization constant appearing in the time-independent part of the isotropic component of the distribution function was assumed to be temperature-dependent, in contrast with earlier assumptions. The results of the analysis were used for calculating the magnitudes of the second harmonic and sum-and-difference frequency components in the reflected waves from an inhomogeneous plasma–free space interface. (auth) (UK)

17642 GRADIENT COUPLING IN INHOMOGENEOUS WARM PLASMAS. Rao, S. S.; Unz, H. (Univ. of Kansas, Lawrence). Astrophys. J., 151: 797-8(Feb. 1968).

Field (1956) derived the wave equation for inhomogeneous isotropic warm plasmas and obtained two coupled equations to show the gradient coupling in the medium due to the presence of inhomogeneous electron density. Recently the gyrotropic problem has been discussed by Rao and Unz (1966), Musal (1965), and a detailed derivation has been given by Unz (1967). This note points out certain disagreements with Field (1956) and gives corrected forms of the coupled equations for the general inhomogeneous case. (W.D.M.)

17643 PROPAGATION OF LONGITUDIAL ION WAVES NEAR AND ABOVE ION PLASMA FREQUENCY IN A PLASMA. Sato, N.; Ikezi, H.; Yamashita, Y.; Takahashi, N.; Obiki, T. (Nagoya Univ., Japan). Phys. Lett., 26A: 333-4(Feb. 26, 1968).

Phase velocities of ion waves are found to be almost frequency-independent at frequencies close to the ion plasma frequency in a plasma of equal electron and ion temperatures, as predicted by the theory. (auth)

17644 WAVE PROPAGATION IN PLASMA GUIDES. Leprince, Philippe (Laboratoire de Physique des Plasmas, Orsay, France). Rev. Phys. Appl., Suppl. J. Phys., 2: 239-44(Dec. 1967). (In French).

Having recalled studies on wave propagation along an unmagnetized plasma column, for various guide structures two different types of mode are studied: plasma modes, i.e., modes existing only with plasma, and waveguide modes that exist without plasma. The presence of a backward wave and the existence of phase velocity greater than the speed of light is studied for the plasma mode. Coupling between the two different modes is evidenced when the plasma frequency is greater than the cutoff frequency of the plasmaless waveguide mode. (auth)

17645 DISTORTION OF AN ELECTROMAGNETIC PULSE CARRIER PROPAGATING IN AN ANISOTROPIC HOMOGENEOUS PLASMA. Ronnang, Bernt O. (Chalmers Univ. of Tech., Goteborg). Contract AF-61(052)-864. IEEE (Inst. Elec. Electron. Eng.) Trans. Antennas Propagation, AP-16: 146-7(Jan. 1968).

Transient signal propagation in anisotropic homogeneous cold plasmas is considered. The anisotropy is caused by an external longitudinal magnetic field. Using the saddle-point method of integration, an approximate expression for the electric field is obtained. The envelope of a distorted rectangular pulse carrier is plotted for various magnetic fields, including the isotropic case. (auth)

17646 DISTRIBUTION OF GAS TEMPERATURE ALONG THE CROSS SECTION OF A DISCHARGE COLUMN IN AIR AT MEDIUM PRESSURES. Panteleev, V. V.; Razinova, S. M.; Vasil'ev, S. S. (Moscow Technological Inst. of Consumer Goods Industry). Zh. Fiz. Khim., 41: 2982-4(Nov. 1967). (In Russian).

Photoelectric methods were used for recording rotation lines in spectroscopic determination of temperature of discharge column plasma in air according to the nitrogen band lines with the edge $\lambda_K = 4059$ Å. The visible intensity of the selected rotating lines of the band was measured along the discharge zone. It was found that the true axial temperature is 100 to 200° higher than the apparent axial temperature and the true average-mass temperature is also 100 to 200° higher than the apparent average mass temperature. (R.V.J.)

17647 PLASMA FLOW EMITTED FROM THE CONTACT POINTS OF AN ARC. Bron, O. B.; Sushkov, L. K. Elektromekhanika, 7-14(Jan. 1967). (In Russian).

Schlieren photography was used to study the particle fluxes emitted at electrodes of various type under the compressive effect of the arc's magnetic field. Longitudinal plasma flows originating at the electrodes are observed in the arc for all the electrodes employed (carbon, copper, brass, and steel). These flows are normal to the electrodes in all cases and maintain their direction unless deflected by an external force. For coaxial electrodes, a collision of the plasma flows is observed which creates radially diverging flows or results in one of the flows being pressed to the electrode. In the collision with an oblique obstacle, the plasma flow is deflected by the latter in the same fashion as a liquid or a gas flow. Cases where two plasma flows are emitted from the same electrode are observed. (IAA)

17648 EXCITATION OF PLASMA ELECTRON OSCILLATIONS BY ION–ACOUSTIC WAVES. Amagishi, Yoshimitsu (Fukushima Tech. Coll., Japan); Kawabe, Takaya. Kakuyugo-Kenkyu, 20: 21-33(Jan. 1968). (In Japanese).

Plasma electron oscillations are experimentally generated by applications of one characteristic low-frequency field to the anode with respect to the cathode, or grid. These oscillations, which are Looney–Brown types, are excited on a phase of the low-frequency fields. The low frequencies correspond to those of radial ion–acoustic wave modes. (NSA of Japan)

17649 ABSORPTION OF BEAM-GENERATED WAVES IN AN INHOMOGENEOUS PLASMA. Seidl, M.; Sunka, P. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 18: 291-3(1968).

A gyrating electron beam was injected into an inhomogeneous magnetic field. Waves are excited in localized regions where the magnetic field is least inhomogeneous. The absorption of these waves is discussed. (M.O.W.)

17650 BEAM–PLASMA INSTABILITIES IN A UNIFORM MAGNETIC FIELD. Seidl, M.; Sunka, P. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 18: 289-91(1968).

High-frequency waves generated by electron beam–plasma instabilities were investigated in the frequency range from 500 to 4000 MHz. The electron beam was injected axially into a stainless steel tube (14 cm diameter, 1 m long) filled with hydrogen gas at a pressure of the order of 10^{-4} torr and immersed in a uniform magnetic field of intensity from 200 to 500 G. The plasma was created by the rf fields generated by the beam–plasma instabilities. The plasma density was varied from 10^{9} to 10^{11} cm^{-3}. (M.O.W.)

17651 THE INFLUENCE OF ACOUSTIC WAVES ON THE POSITIVE COLUMN OF A GLOW DISCHARGE WITH STANDING STRIATIONS. Subertova, S. (Czech Tech. Univ., Prague). Czech. J. Phys., 18: 284-8(1968).

The influence was investigated of low-frequency standing acoustic waves on the positive column of a glow discharge in air and nitrogen in a regime in which spontaneous formation of standing striations readily occurs. Experimental information is presented proving that an acoustic wave of sufficient energy propagating along the discharge axis has a great influence on physical processes creating standing striations in a molecular gas. (auth)

17652 A NOTE ON THE CONSTANTS OF THE LINEARIZED MOTION OF VLASOV PLASMAS. Sedlacek, Z. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 18: 233-9(1968).

It is shown that if a single constant of the linearized motion of a Vlasov plasma is known, it is at once possible to construct an infinite number of other nontrivial constants by using only powers of the Vlasov operator and without making any appeal to the spectral decomposition of the Vlasov operator. (auth)

17653 COLLISIONAL DAMPING OF A PLASMA ECHO. Su, C. H. (Brown Univ., Providence). Phys. Rev. Lett., 20: 427-9(Feb. 26, 1968). (NP-17224).

It is shown that the collisional damping on the free streaming motion of plasma can be very important in certain circumstances even though the collisional frequency is small compared with the plasma frequency. Both spatial and temporal echoes are treated in this note. In the latter case, for example, it is found that the collisional damping goes as $\exp[-\beta\omega_p^2t^3]$ (where β is the collisional frequency). (auth)

17654 DIELECTRIC PROPERTIES OF PLASMA. Bhagavat, G. K.; Ramakrishna, J. (Indian Inst. of Tech., Bombay). Indian J. Pure Appl. Phys., 5: 363-6(Aug. 1967).

Dielectric properties of plasma in a cylindrical capacitor are measured with the help of a Q meter. Variation of permittivity and conductivity of plasma with electron density as well as with the frequency of ac voltage applied are examined. The permittivity of ionized air and argon falls and rises with the frequency of voltage applied, the minimum corresponding to plasma frequency The conductivity of plasma decreases with increase of frequency and rises with increase in discharge tube current. These observations are in agreement with the theory known. (auth)

17655 ENERGY TRANSMISSION FROM ELECTROMAGNETIC FIELD INTO HIGH-FREQUENCY DISCHARGE PLASMA. Kustov, E. F.; Arsen'ev, P. A. (Moscow Inst. of Power Engineering). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 9, 99-103(1967). (In Russian).

Electromagnetic field interactions with plasma were used for determination of the force produced in a discharge as a function of various electromagnetic field parameters, the type of gas, and temperature of discharge. Studies were made of the thermodynamic properties and the energy as functions of the gas temperature and consumption. The data on the energy balance were used for evaluating the resulting temperature and discharge as functions of the electromagnetic field parameters. The results obtained were in agreement with experimental data on the energy and temperature of the discharge. (tr-auth)

17656 LANDAU DAMPING AND ENTROPY. Winterberg, F. (Univ. of Nevada, Reno). Z. Naturforsch., 22A: 1682-9(Nov. 1967).

It is shown that the well-known Landau-damping entropy paradox can be resolved by considering a macroscopic entropy as defined by Clausius instead of the microscopic entropy defined by Boltzmann. Although both entropy definitions are identical for equilibrium configurations, the same in general is not true for nonequilibrium configurations. To extend the entropy definition of Clausius to non-equilibrium configurations requires a generalization of the concept of temperature to nonequilibrium configurations. A natural generalization of the concept of temperature to nonequilibrium configurations is to put the temperature proportional to the mean square velocity fluctuation. In this way a macroscopic entropy can be defined which is then proportional to the logarithm of the mean square velocity fluctuation. In the case of Landau damping it can be shown that two states having the same statistical permutability and thus the same microscopic entropy may have different mean square velocity fluctuations. One should therefore consider, besides the microscopic disorder defined by Boltzmann, which is proportional to the logarithm of the permutability, a macroscopic disorder which is proportional to the logarithm of the mean square velocity fluctuation. In the case of Landau damping the microscopic entropy does not change with time; the macroscopic entropy, however, increases steadily with time. (auth)

17657 ELECTRON ORBITS IN A TOROIDAL PLASMA. Gardner, J. W. (English Electric Co., Leicester, Eng.). Nucl. Energy, 14-17(Jan.-Feb. 1968).

The perturbation theory previously applied to orbits in a cylindrical plasma (straight pinch) is extended to a toroidal plasma (toroidal pinch). Electron trajectories are expressed as expansions in powers of the ratios b/a and ϵ/b, where these quantities relate to the plasma geometry, and $a > b > \epsilon$. (auth) (UK)

17658 PLASMA ECHOES AT UPPER HYBRID RESONANCE. Bauer, L. O.; Blum, F. A.; Gould, R. W. (California Inst. of Tech., Pasadena). Phys. Rev. Lett., 20: 435-9(Feb. 26, 1968).

The experimental observation of a new plasma echo at upper hybrid resonance is reported and a simple theoretical model which exhibits some major features of the results is presented. (auth)

17659 HOT ELECTRON FORMATION BY BEAM-EXCITED PLASMA OSCILLATIONS. Nishikawa, Kyoji (Kyoto Univ.). Prog. Theor. Phys. (Kyoto), 38: 1417-19(1967).

It is pointed out that the heating of electrons above the energy of beam electrons can also be expected from the theory of nonlinear resonant interactions among waves and particles. (M.O.W.)

17660 CONTINUOUS EMISSION SPECTRA OF THERMAL PLASMAS OF RARE GASES. Schlueter, D. (Mitteilung aus der Sternwarte, Bergedorf, Ger). Z. Phys., 210: 80-91(Feb. 5, 1968). (In German).

Absorption cross sections of the rare gases Ne, Ar, Kr, and Xe were calculated by the quantum defect method. From them absorption coefficients for bound–free transitions in thermal plasmas of 8,000 to 16,000°K were derived. The wavelength range considered extends from 2,000 to 7,000 Å. The results are compared with those of other authors and with new experimental data. They agree satisfactorily. (auth)

17661 RADIAL DISTRIBUTION FUNCTION OF A CLASSIC ELECTRON GAS. Kobe, S.; Voss, K. (Technische Univ., Dresden). Z. Naturforsch., 22A: 1866-70(Dec. 1967). (In German).

The equilibrium radial distribution function was calculated, using a modified perturbation series in powers of the plasma parameter. With this method the divergencies of the radial distribution function for short particle distances are overcome. The modified perturbation hierarchy of the URSELL–MAYER correlation functions now can be solved in any order of the plasma parameter. The results in the first order are good with respect to the results of other methods as calculated by CARLEY. (auth)

17662 NONTHERMAL POPULATION DENSITIES IN HYDROGEN PLASMA WITH RADIATION ABSORPTION. Bohn, W. L. (DVL-Institut fuer Plasmadynamik, Stuttgart). Z. Naturforsch., 22A: 1953-9(Dec. 1967). (In German).

Steady-state population densities and electron densities are calculated in a nonequilibrium hydrogen plasma at constant pressure. The ratio of the temperatures of electrons and heavy particles is taken as a parameter. The radiation field of the LYMAN lines is included using a mean absorption coefficient for each transition. The deviations of densities of excited levels and electrons from equilibrium values are very large at low temperatures. The ground state population remains closer to equilibrium until the resonance radiation field vanishes with increasing temperature. Deviations from equilibrium are found to be present even at atmospheric pressure. Detailed results are shown in numerous diagrams for pressures from 0.01 to 1 atmosphere and electron temperatures from 5×10^3 to 4×10^4°K. (auth)

17663 DISTINCTIVE IONIZATION EQUILIBRIUM OF HYDROGEN- AND ALKALI-LIKE IONS IN OPTICALLY THIN PLASMAS. Mahn, C. (Institut fuer Plasmaphysik, Munich). Z. Naturforsch., 22A: 1939-52(Dec. 1967). (In German).

There are many plasmas in which the populations of the various energy states of ions and electrons assume a steady state, but complete local thermal equilibrium is prevented because, on the one hand, radiation absorption is absent and, on the other, the electron density is too low. Calculations for a plasma without radiation absorption show that: where hydrogen-like ions are involved, it is nearly in order to dispense with detailed calculations and describe the ionization equilibrium, with the assumption that the collisional ionization processes from the ground state can be equated with the radiative recombination processes to the ground state. For sufficiently low electron densities this leads to the corona formula. In the case of other ions, however, neglecting the excited states may result in serious errors. This is because these energy states—unlike those for hydrogen-like ions, which are relatively near the ionization limit—are distributed much more uniformly between the ground state and ionization limit. The implications of this behavior are discussed with reference to alkali-like ions. A model for the term systems and the collision and radiation coefficients is used to derive the population densities and approximative ionization formulae. According to these, the ratio of the densities of the lithium-like O VI ions and the next higher level of ions (O VII), for instance, may differ (for electron densities $n_e = 5 \times 10^{17}$ cm^{-3}) from the result of the corona formula by a factor of 20. (auth)

17664 MULTICOMPONENT BEAM–PLASMA WAVES. Verheest, Frank G. (Univ., Ghent). Z. Naturforsch., 22A: 1935-9 (Dec. 1967).

The linearization procedure is applied to the equations governing a beam–plasma system, in which the stream velocities and the wave vector are parallel to the external magnetic induction. No special constraints are imposed on the parameters characterizing the constituent fluids in the equilibrium state of this macroscopic picture. From the MAXWELL equations an expression for the electromagnetic field of the wave is obtained and substituted in the equations of motion. The components of the first-order pressure tensors are computed in the low-temperature approximation, but without recurring to the strong magnetic induction CGL hypothesis. Since the equations of motion are now expressed only in the components of the perturbations of the drift velocities, the dispersion relations follow immediately. These relations are applicable to all beam–plasma systems comprised between the now conventional multicomponent plasma and the system of beams of charged particles. Some known cold beam–plasma cases are included in the general dispersion equations. (auth)

17665 WAVES IN MULTICOMPONENT VLASOV PLASMAS WITH ANISOTROPIC PRESSURE. Verheest, Frank G. (Univ., Ghent). Z. Naturforsch., 22A: 1927-35(Dec. 1967).

The dispersion formulas for small amplitude waves in a fully ionized N-component plasma in the presence of a constant external magnetic field were studied. The number of ion species (whether positively or negatively charged) is left general. From a Boltzmann–Vlasov equation for each component of the plasma the first three moment equations are taken. The low-temperature approximation is used to close the set of equations. This set is then solved together with the equations of Maxwell to obtain a general dispersion relation, a determinant of order 3 N. This relation is studied for the principal waves, and various compact formulas are derived. They are shown to include several known results, when applied to plasmas of the usual compositions. Their general form makes them suitable for various physical approximations. (auth)

17666 THE INFLUENCE OF PLASMA BEAMS ON THE CHARACTERISTIC CURVE OF HIGH CURRENT ARCS. von Bonin, Eckardt; Thiel, Hans AEG Mitt., 57: 420-4(1967). (In German).

In the attempt to obtain data on the effect of plasma beams on the characteristic curves of high current arcs, studies were made on very high currents at 30 kA. It was shown that in this region, the energy balance of the arc is decisively affected by the plasma beam. For a model in which other influences were eliminated, the solution of the energy balance gave at currents over 8.5 kA an approximately ohmic current–voltage characteristic curve, in agreement with experiment. On the basis of these results, possibilities are discussed for the increase of the operating voltage by use of the plasma beam effect. (tr-auth)

17667 THERMAL CESIUM PLASMA IN A STRONG HIGH-FREQUENCY ELECTRIC FIELD. Demirkhanov, R. A.; Khorasanov, G. L.; Sidorova, I. K. (Physical-Technical Inst., Sukhumi, USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 300-2(Nov. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 861-5(Nov. 1, 1967).

Experiments were made with a setup of the Q-machine type with one incandescent plasma emitter. Results are summarized as follows: a strong high-frequency electric field superimposed on a quiet thermal plasma leads to an appreciable increase of the electron temperature; and the plasma heating efficiency increases with increasing frequency of the external alternating field, and this may be of interest from the point of view of turbulent plasma heating. In a nonisothermal plasma situated in a strong high-frequency field, intense oscillations of the ion-sound type are excited, with a frequency much lower than that of the external alternating field. (M.H.R.)

17668 COMPARISON OF AN ANALYTICAL AND A NUMERICAL SOLUTION OF A SIMPLE TYPE OF MOTION OF IONS IN A GAS UNDER THE EFFECT OF A HOMOGENEOUS FIELD. Wieczorek, L. W. (Physikalisch-Technisches Institut, Berlin). Beitr. Plasmaphys., 7: 291-7(1967). (In German).

A comparison was made between an analytical and a numerical method for the solution of the linearized Boltzmann equation under the assumption that the ions are moving exclusively under the effect of an external homogeneous field and under the effect of charge-reversing collisions. The comparison shows that with suitable insertion of the numerical method the distribution function of the ions was represented accurately up to deviations of several percent. The representation of the distribution function of the neutron particle is not as good, especially at small energies. (tr-auth)

17669 SOUND PULSES IN LOW-PRESSURE PLASMA. II. SOUND PROPAGATION. Hayess, Erhard (Physikalisch-Technisches Institut, Berlin). Beitr. Plasmaphys., 7: 327-38 (1967). (In German).

In discharge tubes up to several centimeters of diameter, the same regularities as in un-ionized gas in narrow tubes are valid for the sound propagation in weakly ionized rare gas low-pressure discharges under the assumption of not too high frequencies. This was proved on the basis of systematic measurements of the sound damping and the sound velocity. Within certain limits of the pressure, the sound measurement method can be used for the determination of the mean neutral gas temperature in the discharge. (tr-auth)

17670 THE THEORY OF ARTIFICIALLY PRODUCED MOVING AND STATIONARY LAYERS. I. Fuchs, Vladimir (Charles Univ., Prague). Beitr. Plasmaphys., 7: 339-48(1967). (In German).

It was shown that in the stable regime there are non-trivial temporally asymptotic solutions of the systems of inhomogeneous partial differential equations of the ionization wave theory. With regard to the uniqueness of these solutions, unique possible representations of the wave phenomena, which occurs in a temporally permanent and spatially locally perturbed positive-column plasma, is given for a favorably selected source. Some basic properties of these solutions agree well with observations obtained in experiments with artificially produced stationary and moving layers, which arise behind a local stationary or periodic perturbation. (tr-auth)

17671 PROPAGATION OF SMALL-AMPLITUDE WAVES IN AN INCOMPLETELY IONIZED PLASMA. II. Wilhelm, Johannes; Wisliceny, Johann (Univ., Greifswald, Ger.). Beitr. Plasmaphys., 7: 371-99(1967). (In German).

Part I, the dispersion equations for a plasma in individually given conditions were derived, in which the neutral particle components are explicitly considered. The dispersion equation was discussed for no external magnetic field and for wave propagation parallel to an external homogeneous and constant magnetic field. The dispersion equation is considered now for the propagation of waves perpendicular to the external field. The relations used in I are applied. Some examples for dispersion curves are calculated for two values of the field strength of the external magnetic field. The curves for no external fields are given for comparison. (tr-auth)

17672 PROPAGATION OF SMALL-AMPLITUDE WAVES IN AN INCOMPLETELY IONIZED PLASMA. III. Wilhelm, Johannes; Wisliceny, Johann (Univ., Greifswald, Ger.). Beitr. Plasmaphys., 7: 401-11(1967). (In German).

In Parts I and II, it was assumed that the pressure in all components of the plasma is isotropic. Through the external magnetic field one direction in the plasma is marked out, however, the orbits of the charge carriers can be strongly altered as a result of the magnetic field. If a wave is propagated in the plasma, an additional distinctive direction is established by this. A velocity distribution which made the pressure a scalar is by no means self-evident and is present only under certain conditions. In this part, the effect of a certain pressure anisotropy on the dispersion behavior of waves in the plasma is investigated in the collisions being considered. The methods used previously (phenomenological description, form of the collision term, and wave formulation) are applied. An estimation is obtained of the region in which these methods are suitable from the limitations placed on the generalization by these requirements. (tr-auth)

17673 EQUILIBRIUM CORRELATION FUNCTIONS FOR A TWO-COMPONENT PLASMA. Matsuda, Kyoko (Univ. of California, San Diego, La Jolla). Phys. Fluids, 11: 328-40(Feb. 1968).

The equilibrium correlation functions have been calculated for a high-temperature plasma with enough accuracy to yield the thermodynamic functions to second order in terms of the plasma parameter. First, the classical solutions have been obtained for a two-component plasma and a many-component plasma and compared with the results for an electron gas in a uniform positive background. Second, the convergent solutions have been obtained starting with the quantum Bogolyubov—Born—Green—Kirkwood—Yvon (BBGKY) hierarchy. In the calculation, exchange effects as well as the Heisenberg effect have been taken into account. Also some corrections of the quantum BBGKY hierarchy concerning the symmetry properties have been given. (auth)

17674 VARIOUS EXPRESSIONS OF THE KINETIC EQUATION FOR A PLASMA. Aono, Osamu (State Univ. of New York, Buffalo). Phys. Fluids, 11: 341-5(Feb. 1968).

On the basis of the unified theory, it is proved that the four kinetic equations obtained by Kihara, Baldwin, Frieman and Book, and by Perkins are equivalent to each other and exact in the sense that the Coulomb logarithms with exact numerical factors in the arguments can be obtained by use of any one of them. (auth)

17675 ABSORPTION OF ELECTROSTATIC WAVES BY PLASMA ELECTRONS. Decker, James F.; Hirshfield, J. L. (Yale Univ., New Haven). Phys. Fluids, 11: 372-87(Feb. 1968).

Experimental observations with supporting theory are described of the energy exchange between a plasma column and an externally applied rf electric field that was nearly longitudinal. When electron collisions may be neglected and the wave-particle interaction can be considered weak, the frequency-dependent power absorption, as predicted by solution of the linearized Boltzmann equation, is a resonant process involving electrons having velocities near the phase velocity of the applied field. Similarities between absorption of rf energy in this experiment and collisionless absorption of electron plasma waves are evident, and the experimental results support the ideas of Landau damping. Application of "strong" rf fields to a drifting electron plasma produces a nonlinear deformation of the time-averaged distribution. Measurements of this deformation compare favorably with a quasilinear calculation for weak nonlinear behavior. (auth)

17676 NONLOCAL REFLECTION IN INHOMOGENEOUS MEDIA. Berk, H. L. (Univ. of California, San Diego, La Jolla); Horton, C. W.; Rosenbluth, M. N.; Baldwin, D. E.; Sudan, R. N. Phys. Fluids, 11: 365-71(Feb. 1968).

The physical principle underlying nonlocal wave reflection in a slowly varying spatially inhomogeneous plasma is discussed. In an electrostatically confined system important reflection will arise if there exists points where $[\partial\tau(E,x)/\partial E] = 0$, where $\tau(E,x)$ is the time it takes a resonant particle of energy E at position x to return to the same position. In a mirror field this reflection mechanism can supply sufficiently strong feedback to cause the convectively unstable Post—Rosenbluth loss-cone instability to grow locally in space. (auth)

17677 NUMERICAL INVESTIGATION OF COLLISIONLESS COMPRESSION OF A PLASMA WITH ANOMALOUS FRICTION. Chodura, R. (Institut fuer Plasmaphysik, Munich). Phys. Fluids, 11: 400-8(Feb. 1968).

The effect of friction on the time development of the profile of a strong compression pulse propagating perpendicular to a magnetic field is studied in cylindrical geometry using two-fluid equations. The friction term roughly describes the action of a two-stream instability by limiting the electron velocity to a critical value. Depending on this critical value and on the ratio of electron inertial skin depth to initial plasma radius, the steepening process during compression may or may not lead to a discontinuity. The time history of the profiles and conditions for the occurrence of the discontinuity are investigated for the case that no magnetic field is initially present in the plasma. (auth)

17678 RELATIVISTIC CORRECTION TO PLASMA BREMSSTRAHLUNG. Quigg, Chris (Univ. of California, Livermore). Phys. Fluids, 11: 461-2(Feb. 1968). (UCRL-70586).

A simple relativistic correction to the electron—ion bremsstrahlung spectrum from a Maxwell—Boltzmann plasma is reported. The need for, and accuracy of, the correction are briefly noted. (auth)

17679 PROPAGATION OF TRANSVERSE ELECTROMAGNETIC WAVES IN A MAGNETIZED LABORATORY PLASMA. Brand, G. F.; Hooker, C. A. (Univ. of Sydney). Phys. Fluids, 11: 455-6(Feb. 1968).

The collisional, cold plasma, dispersion relation adequately describes the propagation of electromagnetic waves along the magnetic field in a laboratory plasma. The collision frequency is estimated and its linear dependence on electron density is demonstrated by a new method. (auth)

17680 FREE-STREAMING AND SPATIAL LANDAU DAMPING. Hirshfield, J. L. (Univ. of California, Berkeley); Jacob, J. H. Phys. Fluids, 11: 411-13(Feb. 1968). (UCRL-17713).

The interpretation of experiments on the spatial Landau damping of an electrostatic disturbance is shown to be complicated by the contribution of the free-streaming, initially perturbed particles. In particular, unless measurements give the ratio of the imaginary part to the real part of the wave number to be somewhat less than about 0.4, the observation may be explained using a simple model which neglects the mutual interaction between the plasma particles. (auth)

17681 SUPRA-LUMINOUS WAVES AND THE POWER SPECTRUM OF AN ISOTROPIC, HOMOGENEOUS PLASMA. Lerche, I. (Univ. of Chicago). Phys. Fluids, 11: 413-22 (Feb. 1968).

Using the collisionless Boltzmann equation, equations are set up to describe the electric field autocorrelation function of both longitudinal and tranverse waves in a three-dimensional homogeneous, isotropic plasma. The calculation is performed relativistically for mobile electrons and stationary ions and a general form for the power spectrum is derived. It is demonstrated that as well as the adiabatic power spectrum of Rostoker there are also contributions to the power from waves with phase velocities greater than the speed of light, which persist asympotically in time. There are also "branch cut" contributions which decay in time and Cherenkov wake-background plasma contributions which possess zero energy density asymptotically but which mix the Cherenkov wakes of individual test particles with the supra-luminous wave contributions. This calculation suggests that, in an isotropic, collisionless plasma, the "memory" of the plasma may be many orders of magnitude larger than the Landau damping time. (auth)

17682 FIFTH AND SIXTH APPROXIMATIONS TO THE ELECTRON TRANSPORT COEFFICIENTS. Li, C. P.; Devoto, R. S. (Stanford Univ., Calif.). Phys. Fluids, 11: 448-50(Feb. 1968).

Expressions are given for the fifth and sixth Chapman—Enskog—Burnett approximations to the electron contributions to the transport coefficients of ionized multicomponent mixtures. (auth)

17683 COLLISIONLESS PLASMA SHEATH WITH TRANSVERSE FLOW. Hu, Pung Nien; Ziering, Sigi (Space Sciences Inc., Waltham, Mass.). Phys. Fluids, 11: 451-3(Feb. 1968).

The previously developed sheath model by the authors is herein extended, so as to include the effect on the sheath structure resulting from a transverse bulk flow in the plasma outside the sheath region. (auth)

17684 REFLECTION AND TRANSMISSION OF WAVES FROM MAGNETIZED NONUNIFORM PLASMA SLABS. Kuehl, H. H. (Univ. of Southern California, Los Angeles). Phys. Fluids, 11: 456-8(Feb. 1968).

A theory is outlined which gives the reflection and transmission coefficients for a transverse wave, with propagation direction and electric field perpendicular to the static magnetic field, incident on a thin nonuniform plasma slab. (auth)

17685 LONGITUDINAL OSCILLATIONS IN BOUNDED ONE-DIMENSIONAL NONUNIFORM PLASMAS. Harker, K. J.; Kino, G. S.; Eitelbach, D. L. (Stanford Univ., Calif.). Phys. Fluids, 11: 425-31(Feb. 1968).

A study has been made of the longitudinal oscillations in a one-dimensional nonuniform plasma bounded by specularly reflecting walls. The nonuniformity is assumed to arise from a parabolic shaped static potential distribution. Static magnetic fields are not included. Using Maxwell's equations and the linearized Boltzmann—Vlasov equation, a linear integral equation for the longitudinal electric field is derived. This equation is solved numerically to yield the frequencies and damping rates of the various modes of the plasma. An alternative solution is obtained by using the continuum model. Comparison of results obtained by both methods shows good agreement, in contrast to earlier results for an infinite plasma, for which the agreement was poor. (auth)

17686 MAGNETOHYDRODYNAMIC WAVE MODES BEHIND NORMAL IONIZING SHOCK WAVES. Cross, R. C.; Gross, R. A.; James, B. W.; Watson-Munro, C. N. (Univ. of Sydney). Phys. Fluids, 11: 444-6(Feb. 1968).

The distribution of current loops that develop behind strong ionizing shock waves in a coaxial electromagnetic tube has been studied experimentally and found to be similar to modes excited by two-dimensional magnetohydrodynamic waves. (auth)

17687 STRUCTURE OF A NORMAL IONIZING SHOCK WAVE IN ARGON. Perona, G. E.; Axford, W. I. (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 11: 294-302(Feb. 1968).

The structure of normal ionizing shock waves is studied. Following a discussion of some of the work done in this field, the shock equations are integrated for a simple model. The main assumptions are that the effects of viscosity and thermal conductivity are confined to a very narrow region (thermal shock) across which there is no change in ionization, and that the post-shock gas is only slightly ionized. As an example, the equations governing the structure of a shock in argon have been integrated. The results of these calculations justify the use of the assumptions made in deriving the equations. (auth)

17688 KINETIC THEORY OF PARTIALLY IONIZED GASES. Yen, James T. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Phys. Fluids, 11: 309-15(Feb. 1968).

An approach for evaluating the thirteen moments of the Boltzmann collision integral for electron−ion and electron−neutral collisions in an ionized gas is developed. It is an approximation based on the smallness of the electron mass and is different from the approach of Enskog, Chapman and Cowling, Grad, Burgers and others. The initial inspiration is conceived after a study of the works of Lorentz, Druyvesteyn, Davydov, Allis and others. With the new approach, it is easy to include even higher-order moments and to treat distribution functions which are not locally Maxwellian even in the zeroth order, as well as to study problems with large diffusion velocities and enhanced electron temperatures. The approach is valid, however, only for electron−ion and electron−neutral collisions. For these collisions, the thirteen-moments results agree with those of Burgers when the distribution functions are locally Maxwellian in the zeroth order and the electron temperature is not enhanced. Application of the new approach to various problems is demonstrated. (auth)

17689 EFFECT OF COLLISIONS ON THE INCOHERENT SCATTERING SPECTRA OF PLASMA WITH DIFFERENT ELECTRON AND ION TEMPERATURES. Lepechinski, Dimitri (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 265: 1085-8(Nov. 13, 1967). (In French).

An extension to the case of unequal electron and ion temperatures is made of the Dougherty and Farley method for the calculation of the spectra scattered in the presence of collisions. The extension is based on the Nyquist theorem. Some numerical applications are presented for different cases. (tr-auth)

17690 FACTORS DETERMINING BETA IN A THETA-PINCH EXPERIMENT. Bodin, H. A. B.; Dancy, D. J. (Culham Lab., Abingdon, Eng.). Nucl. Fusion, 7: 191-8(Dec. 1967).

The containment and stability of the theta pinch depend critically upon the value of beta. However, while theoretical calculations predict a value of unity on the axis, experimental results show that the value on axis is substantially less than this. The possibility that these low experimental values are due to a small field diffusion in the early stages of the current sheath formation, followed during the compression, by an energy loss, is examined. Using various values of γ to simulate the effects of energy loss, the variation of beta during the shock phase and during the isentropic compression phase, is calculated. The results are compared with observations on a megajoule theta pinch and it is shown that the penetration of a few hundred gauss during the sheath formation stage can account for the observed values of beta. (auth)

17691 PROPAGATION OF COMPRESSIONAL AND TORSIONAL ALFVEN WAVES UNDER IDENTICAL PLASMA CONDITIONS. Cross, R. C.; Lehane, J. A. (Univ. of Sydney). Nucl. Fusion, 7: 219-22(Dec. 1967).

Measurements are reported for several different sets of plasma conditions. For each set of conditions, velocity and attenuation measurements were made for each wave, and by comparing with theoretical curves, the values of the various parameters determining the wave propagation were obtained. The compressional- and torsional-wave measurements gave independent estimates of the parameters. The two sets of parameters show a broad agreement which is particularly significant since decoupling of the ions from the neutrals is taking place over the frequency range for which the measurements were made. The torsional-wave measurements do, however, imply a higher total density and lower percentage ionization than the compressional-wave measurements. The existence of this difference implies that nonuniformity of the radial density distribution is affecting the wave propagation. (auth)

17692 KINETIC MODEL OF PLASMA COLUMNS. Sestero, A.; Zannetti, M. (EURATOM-CNEN, Rome). Nuovo Cim. (10), 53B: 512-15(Feb. 11, 1968).

Plasma structures in the form of cylindrical columns are often recurrent in theoretical and experimental plasma physics; a simple kinetic model for such structures is investigated here. Cylindrical co-ordinates ρ, θ, z, are used and the assumption is made that all physical quantities depend on ρ only. It is also assumed that the electric field has only a ρ component, and the magnetic field only θ and z components. (M.O.W.)

17693 INVESTIGATION OF PLASMA BEHAVIOR IN THE ALTERNATING ELECTRIC FIELD. I. Pasechnik, L. L.; Ovcharenko, A. A. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 1946-50(Dec. 1967). (In Russian).

The results of plasma behavior studies in the alternating electric field over the frequency range of 1.5×10^5 to 1.5×10^6 cps are presented. Weakening of the alternating electric field was experimentally measured in the presence of plasma of 10^8 to 10^{10} cm^{-3} densities. The experimental results show satisfactory agreement with the calculations in hydrodynamic approximation. The plasma of discharge with a hot cathode in helium at pressures of 10^{-1} to 10^{-2} torr was used. (auth)

17694 INVESTIGATION OF PLASMA BEHAVIOR IN THE ALTERNATING ELECTRIC FIELD. II. Pasechnik, L. L.; Ovcharenko, A. A. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 2032-6(Dec. 1967). (In Russian).

Experimental results are presented of plasma behavior in the alternating electric field with plasma in the magnetic field, the direction of which is perpendicular to that of the electric field. The relative change of the alternating electric field in the discharge chamber with plasma was measured with different magnetic fields 0 to 1200 Oe, plasma densities (10^8 to 10^{10} cm^{-3}), gas pressures (10^{-1} to 10^{-2} torr) and frequencies (1.5×10^5 to 1.5×10^6 Hz). Comparison of the experimental data with the calculations shows that while describing the behavior of magnetized plasma in the alternating electric field the ion component of the plasma must be taken into account. (auth)

17695 A STUDY OF THE MECHANISM OF EXCITATION AND IONIZATION IN THE PLASMA OF AN ARGON ARC. Alexandrov, V. Ya.; Gurevich, D. B.; Podmoshenskii, I. V. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 282-6(Oct. 1967).

Translated from Opt. Spektrosk., 23: 521-7(Oct. 1967).

The plasma of an argon arc was investigated in a state close to thermodynamic equilibrium. It was found that the reason for the disturbance of the latter is the departure from the principle of detailed equilibrium for ionization and recombination in the discharge zone. The connection between the excitation and ionization temperatures and the electron temperature is discussed. The recombination coefficient was observed to be $\alpha = 4$ to 6×10^{-11} cm^3 sec^{-1} for $n_0 = 3.0 \times 10^{15}$ cm^{-3}, $T_e = 6600$°K, and $T_g = 6000$°K. (auth)

17696 AN INVESTIGATION OF THE DEPENDENCE OF THE ELECTRIC AND SPECTRAL PROPERTIES OF A GAS DISCHARGE ON THE FREQUENCY OF THE EXCITING FIELD. Motornenko, A. P. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 286-9(Oct. 1967).

Translated from Opt. Spektrosk., 23: 528-34(Oct. 1967).

The electron temperature and charged-particle density in the discharge were measured as a function of the wavelength of the exciting generator for $\lambda_{exc} = 10$ to 140 m. The electrical and spectral properties of the gas discharge are compared. The emission spectrum of high-frequency ($\lambda_{exc} = 14$ m) and microwave ($\lambda_{exc} = 3.2$ cm) discharges are compared when the sources have equal electrical field intensity. It is demonstrated that the emission spectrum of the discharge depends on the frequency of the exciting field. (auth)

17697 EXPERIMENTAL STUDY OF THE ACCELERATION OF IONS IN A HIGH FREQUENCY ACCELERATOR WITH STATIC MAGNETIC FIELD GRADIENT. COMPARISON WITH THEO-

RETICAL RESULTS. Bardet, Rene; Abgrall, Francois; Finzi, Umberto; Geller, Richard (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 265: 1013-16(Nov. 6, 1967). (In French).

The plasma formed by a continuous-wave accelerator of the Circe type is injected in the uhf cavity of a stationary-wave accelerator of the Pleiade type. The experimental results are compared with the theoretical laws developed by E. Canobbio. There was experimental verification of the theoretical principles of this type of accelerator. (J.S.R.)

17698 NIZKOTEMPERATURNAYA PLAZMA. Trudy Mezhdunarodnogo Simpoziuma po Svoistvam i Primeneniyu Nizkotemperaturnoi Plazmy pri XX Mezhdunarodnom Kongresse po Teoreticheskoi i Prikladnoi Khimii, Moskva, Uyul 15–17, 1965. (Low-Temperature Plasma. Proceedings of the International Symposium on the Properties and Applications of Low-Temperature Plasma at the XX International Congress on Theoretical and Applied Chemistry, Moscow, July 15–17, 1965. Sheindlin, A. E. (ed.). Moscow, Izdatel'stvo MIR, 1967. 631p. (CONF-650723).

Sixty three articles are included on low-temperature plasmas. Data are presented on elementary processes and mechanisms of reactions in low-temperature plasma, including processes taxing place with participation of two or more atomic particles. Also included are: plasma properties; method for preparation and investigation of low-temperature plasma; studies of magnetohydrodynamics; and uses of low-temperature plasma in chemistry and chemical technology. (R.V.J.)

Production of Plasma

17699 MAGNETOACOUSTIC RESONANCE FOR NONLINEAR EXCITATION IN A COLD PLASMA. Faessler, K.; Vaclavik, J.; Schneider, H. (Univ., Freiburg i. B.). Phys. Lett., 26A: 270-2(Feb. 12, 1968).

In magnetoacoustic resonance, amplification of the exciting magnetic field B_Z was studied in the region where B_Z is not small compared with magnetostatic field B_O. Dependence on the mutual polarity of B_Z, B_O and on the exciting energy was found and excitation of higher harmonics was observed. (auth)

17700 FORMATION MECHANISM OF A LASER-PRODUCED PLASMA. Griffin, W. G.; Schluter, J. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Lett., 26A: 241-2 (Feb. 12, 1968).

By observation of the time-dependent absorption of laser light at a focus on thin films of polythene the velocity of the absorbing layer in the solid was measured to be 2.5×10^5 to 7.5×10^5 cm/sec for flux densities of 3×10^{10} to 80×10^{10} W/cm^2. (auth)

Stability of Plasma

17701 (MIAPH-PL-67,10) VARIATIONAL APPROACH TO THE DYNAMIC STABILITY OF HIGH DENSITY PLASMAS IN MAGNETIC CONTAINMENT DEVICES. Wells, Daniel R.; Norwood, Joseph Jr. (Miami Univ., Coral Gables, Fla. Dept. of Physics). [1967]. 43p. Dep. CFSTI.

Variational methods are used to determine the structure of dynamically stable plasmoids. The total energy of the plasmoids is varied subject to a set of constraint integrals on the flow. It is demonstrated that the resulting flow structure in an azimuthally symmetric geometry results in a plasmoid of the type observed experimentally when the angular momentum of the plasmoid is not conserved. This is the colinear vortex structure. New experimental results are presented which clearly demonstrate that the structures observed in mirror-trapping experiments are of the type predicted by the variational calculation. The colinear plasmoid structures are shown to be members of a class of nonlinear transverse waves that trap and transport fluid mass. The interaction of the nonlinear transverse waves (plasmoids) with each other and with the magnetic mirror field produces a reversed-field closed configuration. Experimental results are presented which illustrate these effects and show details of the structures. It is also demonstrated that a modification of these solutions that assumes conservation of angular momentum of the plasmoid describes another type of plasma structure which is centered on the magnetic field lines and moves at right angles to the field. This is the field aligned plasma structure. (auth)

17702 MAGNETIC BEHAVIOUR OF A RESONANTLY SUSTAINED PLASMA AT HIGH HF POWER. Vandenplas, P. E.; Messiaen, A. M. (Ecole Royale Militaire, Brussels). Phys. Lett., 26A: 273-4(Feb. 26, 1968).

The density of a resonantly sustained plasma column is observed versus axial magnetic field B_0. A striking pattern showing the role of the cyclotron harmonics and extinction at the cyclotron frequency is observed and theoretically interpreted. The evolution of the plasma "tongues" versus B_0 is suggestive. (auth)

17703 ON THE EFFECT OF THE MULTIPERIODIC HF FIELD ON THE TWO-STREAM INSTABILITY IN A COLD PLASMA. Teichmann, J. (Inst. of Plasma Physics, Prague). Phys. Lett., 26A: 328-9(Feb. 26, 1968).

The new method for stabilizing plasma instabilities, based on the application of the multiperiodic hf field is discussed on the example of the two-stream instability. The growth rate falls proportionally to the number of applied frequencies. (auth)

17704 EFFECT OF VISCOSITY OF PLASMA INSTABILITIES. Ohnuma, Toshiro; Hatta, Yoshisuke (Tohoku Univ., Sendai). Kakuyugo-Kenkyu, 20: 1-20(Jan. 1968). (In Japanese).

Effects of electron and ion viscosity on plasma instabilities are investigated in the plasma system including ion–neutral and electron–neutral collisions. In the waves propagating parallel to magnetic field, the low-frequency mode becomes unstable with the existence of the viscosity of the drift electrons. The critical velocity for the instability and the unstable region for large wave number are shown with the parameter of T_e/T_i. The waves in a high-frequency region are also shown to be excited with the existence of the ion viscosity. Further, the low-frequency wave which propagates perpendicular to a weak magnetic field is shown to be excited with the existence of the viscosity of the drift electrons. (NSA of Japan)

17705 IONIZATION INSTABILITY OF PLASMA IN CROSSED FIELDS. Shipuk, I. Ya.; Pashkin, S. V. Dokl. Akad. Nauk SSSR, 176: 1278-81(Oct. 21, 1967). (In Russian).

The density of weakly ionized plasmas may be changed by ionization and recombination processes; this results in the excitation of specific ionization instability in the positive discharge column. Such instabilities may also arise in a magnetic field when the conductivity of the plasma becomes anisotropic. This problem was studied by carrying out a discharge in a glass tube with a rectangular cross section, containing argon and cesium vapors. The tube and its thermostat were placed in a homogeneous magnetic field with the H value varied from 0 to 50 oersted. The discharge current density was about 2 A/cm^2 with a time constant of 10^{-2} sec. The study involved the measurement of the electron temperature, the electron density, and the mean electric field determining also the moment of generation of the instabilities, their velocity and oscillation spectra. It was found that the spatial spectrum of the inhomogeneities was strongly anisotropic except when the plasma became very turbulent. The frequency of oscillation was very close to 10^3 kHz; the velocity of the layers was about 10×10^3 cm/sec. The transition from the laminar to turbulent state was found to be similar to the development of turbulence in ordinary hydrodynamics. (TTT)

17706 EFFECTS OF MAGNETIC SHEAR ON DENSITY GRADIENT DRIFT INSTABILITIES. Kitao, Kazuo (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Naturforsch., 22A: 1689-1700(Nov. 1967).

The amounts of magnetic shear necessary to stabilize density gradient drift instabilities are estimated for a plasma with $1 \gg \beta > m/M$ where β = plasma pressure/magnetic pressure, m and M are the electron and ion masses. The stability criteria for electrostatic convective modes are shown to be slightly modified from those obtained previously for $\beta < m/M$. For $\beta > m/M$ however, we must also consider unstable Alfvén type modes. It is shown that the critical amount of magnetic shear is proportional to β^{-1} for the convective Alfvén type modes and to $\sqrt{\beta}$ for the nonconvective modes. (auth)

17707 CYCLOTRON INSTABILITY IN A HOT ELECTRON PLASMA WITH A DOUBLE-HUMPED VELOCITY DISTRIBUTION. Perkins, W. A.; Barr, W. L. (Univ. of California, Livermore). Phys. Fluids, 11: 388-99(Feb. 1968).

A high-frequency instability occurring in a "hot electron" plasma ($T_e \approx 25$ keV; $N_e \approx 10^{11}$ cm^{-3}) contained in a quadrupole-mirror machine (i.e., "minimum-B" field) has been studied experimentally and correlated with theory. The effects observed in the presence of instability bursts are: (1) Intense radiation is emitted at the electron-cyclotron frequency; (2) a short pulse of electrons escapes along the field lines; and (3) the double-humped energy distribution (characteristic of the electrons just before the instability) changes so that the distribution of the hot electron component becomes more nearly Maxwellian simultaneous with a marked increase in the 200-eV component. The experimental observations are compared with the theoretical calculations of Hall, Heckrotte, and Kammash as modified to apply to the measured experimental distributions. In agreement with the observations, these calculations predict the occurrence of an instability at low plasma density, such that $\omega_{pe}^2/\omega_{cp}^2 \approx 0.01$. In addition, the required presence of a cold electron component, the predicted growth rate of 2×10^7/sec, and the prediction of instability frequencies at ω_{ce} are all in agreement with the observations. The present picture is, therefore, that the instability derives from the "loss-cone" nature of the distribution functions of the hot electrons (arising from the fact that they are contained in an open-ended system where scattering into the loss cone is the main loss mechanism), coupled with the presence of a cold electron component. (auth)

17708 EQUILIBRIA AND STABILITY OF COLLISIONLESS PLASMAS IN CYLINDRICAL GEOMETRY. Marx, K. D. (Univ. of California, Livermore). Phys. Fluids, 11: 357-65(Feb. 1968). (UCRL-70399(Rev.1)).

The general equilibrium and neighboring-equilibrium (tearing mode) problems for cylindrical plasma configurations roughly corresponding to the Astron E layer are solved relativistically for a Gaussian velocity distribution function. A family of equilibrium solutions and stability domains is computed for arbitrary E-layer thickness and degree of field-reversal. The solutions have the peculiarity that the equilibrium density is finite (exponentially decaying) at large radii; whereas the tearing mode is always unstable unless a conducting wall is placed at a finite radius. This inconsistency in the analysis is resolved by treating a sharp-edged plasma with a monoenergetic, single-canonical-momentum distribution function. (auth)

17709 EFFECT OF THE FINITE ION LARMOR RADIUS ON THE KELVIN-HELMHOLTZ INSTABILITY. Melchior, Henning; Popovich, M. (Danish Atomic Energy Commission, Roskilde, Denmark). Phys. Fluids, 11: 458-60(Feb. 1968).

The Kelvin-Helmholtz instability is described with the effects of the finite ion Larmor radius included. The growth rate is computed for several values of the velocity shear and different density profiles. (auth)

17710 SOME CONSIDERATIONS ON CLOSED CONFIGURATIONS OF MAGNETOHYDROSTATIC EQUILIBRIUM. Palumbo, D. (EURATOM, Brussels). Nuovo Cim. (10), 53B: 507-11 (Feb. 11, 1968).

The possibility of magnetohydrostatic equilibrium in toroidal configurations for which the drift velocity $v_d = v_g + v_c$ is tangent to the magnetic surface P = constant is considered. Only the case of an ideal plasma with scalar pressure P and zero electrical resistivity is considered. (M.O.W.)

17711 HIGH-FREQUENCY INSTABILITIES IN BEAM-GENERATED PLASMA. Seidl, M.; Sunka, P. (Inst. of Plasma Physics, Prague). Nucl. Fusion, 7: 237-51(Dec. 1967).

High-frequency instabilities arising in electron beam-plasma systems were investigated in the frequency range $0.4\ \omega_{ce} \leq \omega \leq 4\omega_{ce}$. Two types of electron beams (cold and helical) and two types of magnetic fields (uniform and mirror field) were used. The plasma was created from hydrogen gas by the beam-induced rf fields. In the uniform magnetic field, the spectrum of the instabilities is in good agreement with a simple linear theory, taking into account the finite transverse dimensions of the system. This is true even in the turbulent state of the plasma ($\omega_{pe}/\omega_{ce} > 1$), in contradistinction to earlier experiments, if the fluctuations of plasma density are taken into account. The plasma has a tendency to exist at discrete values of density corresponding to the excitation of electron cyclotron frequency harmonics. The instabilities have a finite relaxation time (about 100 oscillation periods) and a finite relaxation length (about 5 wavelengths) due to nonlinear effects. In the case of a mirror field, the instabilities are excited in regions where the field is least inhomogeneous (top of the mirrors and bottom of the containment zone). The heating of electrons occurs at the slope of the mirror. The significance of these results for the heating of electrons in a mirror machine is discussed. (auth)

17712 KINETIC THEORY OF STABILITY OF A NONUNIFORM PLASMA IN AN ELECTRIC dc FIELD. Bogdankevitch, L. S.; Milic, B.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Nucl. Fusion, 7: 199-205(Dec. 1967).

Consideration is given to the resistive drift modes both at low frequencies and at ionic gyro resonances of a nonuniform low-pressure plasma placed in an external magnetic field and in a longitudinal electric field. The spectra of instabilities are discussed for the kinetic range of frequencies where the two-fluid hydrodynamical description is not applicable. Kinetic equations for ions and electrons with Landau collision integral are used. The conditions of instability are analyzed on the basis of local spectra obtained in the approximation of geometrical optics. Special consideration is given to the drift of the electrons. For every mode the criterion of stabilization by magnetic shear is specified. All resistive drift modes in the kinetic range of frequencies in a nonuniform plasma with current are discussed. (auth)

17713 EQUILIBRIUM OF A TOROIDAL PLASMA COLUMN IN STEADY-STATE AND HIGH-FREQUENCY MAGNETIC FIELDS. Gutkin, T. I.; Lozovskii, S. N.; Boleslavskaya, G. I. (Physical-Technical Inst., Sukhumi, USSR). Nucl. Fusion, 7: 185-90(Dec. 1967).

The equilibrium of a toroidal plasma column in a steady-state magnetic field is considered in a multipole high-frequency field produced by currents flowing around the major circumference of the torus which are proportional to $\exp[i(\omega t - n\psi)]$, where ψ is the polar angle in the meridional cross section of the torus and ω is the frequency determined by the generator. The possibility of achieving equilibrium is shown when the pressure of the high-frequency field is less than the kinetic pressure of the plasma, ignoring the reaction of the circuit to the displacement of the plasma column; i.e., it is assumed that this displacement does not give rise to image currents in the circuit. An expression is derived for displacement of the column as a function of the amplitude of the high-frequency field, the kinetic pressure of the plasma, the depth of the skin layer, the multipole order (n), and of geometric parameters such as the radius of the plasma column r_p, the radius of the circuit r_k and the radius of the torus R. The displacement of the column is proportional to the kinetic pressure of the plasma, inversely proportional to the square of the amplitude of the current in the circuit, and independent of the steady-state magnetic field. Expressed as a function of the multipole order (n), displacement is at a minimum when n is equal to the whole number closest to $1 + [\frac{1}{2}\ln(r_k/r_p)]$. When $r_k/r_p \sim 2$, the optimum value of n is 2 (quadrupole). When n = 1 (dipole), displacement increases in proportion to $\ln(c/\omega r_p)$. On the assumption of a quasi-steady state ($c/\omega r_p \gg 1$), equilibrium containment of the plasma in the dipole case is found to be difficult to achieve in practice. When n = 0, equilibrium is quite impossible to achieve. The validity of this conclusion is dependent on the assumption of a quasi-steady state and on the further assumption that the circuit will not react to displacement of the column. (auth)

Shielding

Refer also to abstracts 17389 and 18102.

17714 (GEMP-582) CONICAL AND PLANE SURFACE SCATTERING. PROGRAM SURF. MacDonald, J. E. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Feb. 1968. 60p. Dep. CFSTI.

Program SURF, GE-NMPO program NMP-854, calculates neutron and gamma-ray dose rates and flux distributions in energy at unshielded receiver points due to direct beam and once-scattered radiation from anisotropic point sources. Only one scattering structure with either conic or slab geometry is allowed. Attenuation of radiation in the scattering structure is neglected. The program was written in Fortran IV for the GE-625 requiring 32K fast memory. No tapes, drums, or disks are required apart from the system input and output tapes. The program is in production status. (auth)

17715 (RISO-M-663) USER'S MANUAL FOR THE AEK SHIELDING PROGRAMMES P-18, 19, 20, 63, 220, 374. Kirkegaard, Peter (Danish Atomic Energy Commission, Risoe. Research Establishment). Dec. 12, 1967. 112p. Dep.

Detailed instruction is given in the use of the series of shielding programs, developed at Risö since 1963: PRIGAM, SEGAM I, SEGAM II, REMTHERM, MC4, and REMDIFF. The present report replaces Risö-M-491. (auth)

17716 (UCID-15284) GEISHA-II: A CDC 6600 CODE FOR USE IN PARAMETRIC SPACE SHIELDING SURVEYS. Wilcox, T. P. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 7, 1966. Contract W-7405-eng-48. 43p. Dep. CFSTI.

Geisha-II is a point kernel shielding code written to perform parametric surveys that will be useful in designing the shield and reactor of space power systems. The code is able to vary the core's, and consequently the reactor system's, size by using neutronic constraints. If desired, the code will also vary the shield's thickness to obtain a given dose rate at the payload. It will also vary the shield's position to insure that the maximum shield temperature is below a given value. Secondary gamma production is included as well as are core fast neutrons and six energy groups of gammas. Both component and system total weights are indicated in the final output. The main calculations of the code are; 1) the size of the core; 2) the neutron flux at the payload; 3) the core gamma flux at the payload; 4) the secondary gamma flux at the payload; and 5) the shield heating rate and maximum temperature. Re-cycling is done to vary the shield thickness and position if this is desired. The neutron calculation makes use of the standard removal theory. The gamma calculations use similar theory with buildup factors. Six gamma groups are used to account for spectral changes occurring in thick shields. (M.H.R.)

17717 THE PROPAGATION OF THE NEUTRON COMPONENT OF THE NUCLEONIC CASCADE AT ENERGIES LESS THAN 500 MeV: THEORY AND A SOLUTION TO THE ACCELERATOR TRANSVERSE SHIELDING PROBLEM. O'Brien, K.; McLaughlin, J. E. (Health and Safety Lab., New York). Nucl. Instrum. Methods, 60: 129-40(Mar. 15, 1968).

Polynomial transport theory was applied to the neutron component of the nucleon-meson cascade at energies less than 500 MeV. Nonelastic and elastic processes, and hydrogen scattering were taken into account, using relativistic kinetics wherever appropriate. Neutron spectra in the lateral shielding of 3 types of accelerators were calculated. The spatial distribution of the dose-equivalent rate on the exterior surface of these accelerators was estimated using plausible assumptions about beam loss. It appears from the results that the theory of the neutron component of the cascade is sufficient to determine the flux and dose-equivalent rate in and about the lateral shielding of most large accelerators; or whenever the mean deviation of secondary neutrons, having energies greater than 500 MeV, from the primary beam, is less than about 15°. (auth)

17718 BROAD-BEAM GAMMA ATTENUATION IN THIN ABSORBERS. Stewart, Elmon Bill; Ledbetter, Joe O. (Univ. of Texas, Austin). Amer. Ind. Hyg. Ass. J., 29: 94-100(Jan.-Feb. 1968).

The investigation of broad-beam gamma attenuation by thin sections of steel, aluminum, and glass was undertaken because of a dearth of such data on these important structural materials. Evaluating the shielding capabilities of automobiles and modern buildings requires knowledge about the broad-beam attenuation of gamma radiation under the conditions of these experiments. For calculations of broad-beam gamma attenuation by thin sections of steel, assuming exponential attenuation ($B_n = 1.0$) will not cause serious error (<10%). The buildup factors for the thin sections of aluminum and glass varied exponentially with the thickness, i.e., $B_n = e^{kx}$, where k was constant over the range of experiments (~0.317 for the alumimum and glass). (auth)

17719 BACKSCATTERING OF GAMMA RAYS FROM POLYETHYLENE, ALUMINUM, AND LEAD SLABS. Mizukami, Koichi; Matsumoto, Takaaki; Hyodo, Tomonori (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 4: 607-13(Dec. 1967).

Spectra of backscattered radiation from finite thick slabs of polyethylene, aluminum, and lead were obtained by means of a scintillation spectrometer. A point ^{60}Co γ source was placed in close contact with a scattering slab. Variations of number and energy albedo values with increasing slab thickness are given as experimental formulas and graphical representations. (auth)

17720 THE APPLICATION OF TRACK-LENGTH DISTRIBUTION BIASING IN MONTE CARLO DEEP-PENETRATION CALCULATIONS. Karcher, R. H.; Erdmann, R. C.; Baldonado, O. C. (Holmes and Narver, Inc., Los Angeles). Nucl. Sci. Eng., 31: 492-9(1968).

The feasibility of track-length distribution biasing for the calculation of spatial and angular particle flux far from the source in an infinite medium is investigated. Calculations are performed for an idealized particle transport model having an exact analytical solution, and results for scalar flux are given to a penetration distance of approximately 60 mean-free-paths. Results are also given for angular distributions. It is found that the "optimum" biasing parameter "a" for scalar flux prediction can be approximated by $a \exp(-a) = 0.368c^{n/40}$ (a revised form of an empirical expression from an earlier study), where c is the probability of scatter and n is the desired penetration distance. If appropriate corrections are made for the effects of inelastic and hydrogen scatter, the present results can provide useful guidance in the application of the track-length distribution biasing technique to more realistic systems. (auth)

17721 THE USE OF SELF-OPTIMIZED EXPONENTIAL BIASING IN OBTAINING MONTE CARLO ESTIMATES OF TRANSMISSION PROBABILITIES. Levitt, Leo B. (Atomics International, Canoga Park, Calif.). Nucl. Sci. Eng., 31: 500-4(1968).

A method of increasing the sampling efficiency in Monte Carlo calculations of thick-shield penetration has been developed. The procedure alters the effective mean free path in such a way as to maximize the rate of convergence of the transmission probability. The approach is semiempirical in nature and has been shown to be remarkably insensitive to geometry. The primary dependence appears to be on the nonabsorption probability at each collision, with secondary dependence on the distance to escape. The procedure is simple enough to permit its incorporation into existing Monte Carlo codes with a minimum of programming effort. (auth)

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Refer also to abstracts 16966, 17367, 17386, 17420–17422, 18088, 18197, and 18309.

17722 (COO-1198-512) HIGH-PRESSURE MOESSBAUER STUDIES ON IRON AND ITS DILUTE ALLOYS. Moyzis, Joseph Andrew Jr. (Illinois Univ., Urbana). Feb. 1968. Contract AT(11-1)-1198. 161p. Dep. CFSTI.

The Moessbauer effect has been used to study the effect of very high pressure on dilute alloys of ^{57}Fe in iron, copper, vanadium, and titanium at room temperature. The pressure dependence of the Moessbauer f number for ^{57}Fe in copper, vanadium, and titanium was studied. Values of the Debye parameter θ and the second inverse moment of the lattice spectrum for the host metals are obtained. The pressure dependence of the Moessbauer isomer shift for ^{57}Fe in iron, copper, vanadium, and titanium was studied. An analysis of the iron data gives a relation between the isomer shift parameter and the redistribution, with volume, of the iron conduction electrons between the 4s and 3d bands. Similar analyses are made for copper, vanadium, and titanium. 160 references. (auth)

17723 (COO-1624-11) NUCLEAR RADIATION EFFECTS ON SILICON P-N JUNCTIONS. Technical Progress Report. Goben, Charles A. (Missouri School of Mines and Metallurgy, Rolla). Feb. 1968. Contract AT(11-1)-1624. 45p. Dep. CFSTI.

Equipment has been purchased (or fabricated) and integrated to form the sophisticated electronic measuring apparatus required for studying nuclear radiation effects in silicon p−n junctions. The effects of neutron irradiation on the collector junction parameters, which indicate that recombination takes place in the collector junction, have been noted and apparently can be explained only by adding a term to the normal gain expression to account for this recombination. In the moderate-to-high current-level region, that is, during and after the onset of conductivity modulation, a bulk recombination phenomena is predicted and observed to account for degradation of transistor current gain. This phenomena is under investigation. Work is in progress to examine the anomalous annealing phenomena reported by the principal investigator for the neutron-induced defects in the neutral and space-charge regions of p−n junction devices through isothermal and isochronal annealing techniques. A study is being made of the radiation and annealing behavior of devices operated in the inverse configuration so that a relatively wide depletion region is available for determination of the damage constant for the neutron-induced current component originating in the depletion layer. It has been determined that the neutron-induced defects are field dependent and a study is under way to determine more about the fundamental properties of these defects. A quasi-tunneling model is being investigated to determine if this model will correctly predict the observed changes induced by neutron bombardment at low and intermediate current levels. Work is in progress to construct and fit a statistical recombination model to the observed neutron-induced base current component in silicon transistors. (auth)

17724 (JAERI-Memo-2054) ELECTRON SPIN RESONANCE OF GAMMA RAY IRRADIATED SINGLE CRYSTALS OF SODIUM NITRATE. Geshi, Kazuo; Kazumata, Yukio (Japan Atomic Energy Research Inst., Tokyo). 1965. 39p. Dep.

Electron spin resonance spectrum of single crystals of $NaNO_3$ irradiated with ^{60}Co gamma rays both at room temperature and at 77°K was measured. The signals of the specimen irradiated at room temperature are assigned to NO_2 and NO_3 distributed on three different crystal sites. The signals of the specimen irradiated at 77°K and measured at 77°K without any intermediate heating are assigned to NO_2, NO_3, NO_3^{--}, and O_2^-. The orientation of the radicals and the effect on the radical formation of the temperature during the irradiation are discussed. (auth)

17725 (NYO-2047-42) INVESTIGATIONS OF RADIATION EFFECTS IN SOLIDS BY ELECTRON SPIN RESONANCE. Progress Report, February 1, 1967–January 31, 1968. Gilliam, Otis R. (Connecticut Univ., Storrs. Dept. of Physics). Contract AT(30-1)-2047. 27p. Dep. CFSTI.

Radiation-induced defects in nonmetallic single crystals are being investigated by electron spin resonance and by optical absorption methods. The 1-MeV electron accelerator has been used to generate hydrogen atomic displacements in ammonium bifluoride crystals. Neutral hydrogen atoms and F_2^- ions, have been studied by ESR following the irradiation at 77°K. The F_2^- ions reside in three inequivalent sites. Two of F_2^- ions are shifted in angle from the normal anion orientations, indicative of radiation-induced lattice distortion. Measured optical absorptions agree closely to the 2.1- and 4.0-eV bands reported earlier for irradiated potassium bifluoride, for which the latter band was correlated with the F_2^- ion. Similar studies are in progress on sodium bifluoride crystals. Gamma-ray or electron irradiation of potassium cyanate (KNCO) yields blue coloration and two paramagnetic species. One ESR spectrum consists of an $S = \frac{1}{2}$ three-line hyperfine structure with an isotropic g value of 1.999, isotropic hyperfine constant of 2.3 G, and an anisotropic hyperfine constant of 2.7 G. This spectrum is attributed to a rotating CN neutral molecule restricted to rotation in the (110) and $(1\bar{1}0)$ planes of the tetragonal unit cell. The spin-Hamiltonian parameters of the other defect suggest that it is a θ^- ion in two inequivalent sites. Optical absorption measurements have been made. A similar study is being made on sodium cyanate crystals. Investigations of gamma- and electron-irradiated $CaMoO_4$ yielded results similar to those reported by Zeldes and Livingston for calcium tungstate and tend to confirm their preferred defect models. Differences in experimental findings are reported and ESR data are given for an $(MoO_4)^{3-}$ ion and for a O_2^{3-} ion and for a O_2^{3-} ion where the hole is shared between oxygens in adjacent molybdate ions. Also observed following electron irradiation is a delocalized hole stabilized near a sodium impurity cation. In $CaMoO_4$ samples with appreciable Nb impurity ions a new spectrum has been detected following gamma irradiation at 77°K. It results from a valence change of the Nb impurity ion from V to IV. This defect displays an effective spin of $\frac{1}{2}$, four inequivalent sites, a prominent hyperfine interaction with Nb with $I = \frac{9}{2}$, and also hyperfine interaction with Mo nuclei. These spectra are being analyzed. (A.G.W.)

17726 (ANL-Trans-565) CRYSTAL STRUCTURES AND PROPERTIES OF THE METALS OF LONG PERIODS IN CONNECTION WITH THEIR ELECTRON STRUCTURE. Grigorovich, V. K. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Tr. Inst. Met. im. A. A. Baikova, Akad. Nauk SSSR, No. 12, 241-63(1963). 28p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

The crystal structure and properties of the metals of the long periods are correlated with the structure of their outer electron shells. Properties considered include ionization potentials, melting points, boiling points, evaporation heats, moduli of elasticity, hardness, and interatomic distances. (A.G.W.)

17727 (LA-tr-68-5) SPECIAL CRYSTALLOGRAPHIC RELATIONSHIPS OF LATTICE GROUPS. Niggli, P. Translated by Margaret Prince (Los Alamos Scientific Lab., N. Mex.), from Chapter 4, Section 1, pp 108-16 of Krystallographische und Strukturtheoretische Grundbegriffe, Handbuch der Experimentalphysik, Vol. 7, Pt. 1, Leipzig, 1928. 11p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

In order to prove the equivalence of two quadratic forms (two space lattices), each quadratic form must be reduced. If they are equivalent to one another, they must give the same reduced form. The reduction of the specific positive ternary quadratic forms corresponds to the representation of a space lattice by a distinguished, easily found primitive triplet. General rules are given for the reduction process. Conditions by which the reduced form may be recognized are listed. (A.G.W.)

17728 (ORNL-tr-1889) THE CRITICAL SHEAR STRESS OF CUBIC CRYSTALS WITH DEFECTS OF TETRAGONAL SYMMETRY. I. ON THE SHORT-RANGE INTERACTION OF DISLOCATIONS WITH ELASTIC DIPOLES. Frank, Werner. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Z. Naturforsch., 22A: 365-76(1967). 21p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

In cubic crystals, flaws with tetragonally symmetrical fields of deformation enter into strong interaction with the dislocations. In the present study is calculated the contribution to the critical shear stress that originates in the short-range forces of interaction between dislocations and tetragonal flaws lying in the slip plane or in its immediate vicinity. It is taken into consideration that in the slippage of dislocations on such elastic dipoles, these can change their orientations. Moreover, certain dipoles, for example, small disk-shaped precipitates, can be cut through by the dislocations. (auth)

17729 MEASUREMENT BROADENING CORRECTIONS IN MAGNETIC RESONANCE. Svanson, S. E.; Stenloef (Univ. of Gothenburg, Sweden). Ark. Fys., 34: 277-37(1967).

Corrections were derived for the calculation of the Fourier transforms of magnetic resonance lines from experimental data, obtained by using phase-detection techniques. The results were verified experimentally for modulation broadening to within a few per cent, even in cases of considerable line distortion. A new method for the measurement of modulation amplitude is also described. (auth) (Sweden)

17730 ELECTRIC PROPERTIES OF SOLID SOLUTIONS OF ZrC-NbC. Avgustinik, A. I.; Golikova, O. A.; Kudryasheva, L. V.; Ordan'yan, S. S.; Snetkova, V. A. (Leningrad Technological Inst.). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1823-7 (Oct. 1967). (In Russian).

In solid solutions of ZrC-NbC the concentration of the current carrier increases in proportion to the increase of the concentration of niobium—a metal of much higher valency than zirconium. The presence of defects (carbon vacancies) in the metalloid sublattice and deformation (atoms of other valencies) in the metal sublattice affects, comparatively weakly, the mobility of the current carriers. The mobility of the carriers was established basically by their concentration. The zone structure in solid solutions of ZrC-NbC changes less in comparison with the zone structure of ZrC at Nb concentrations up to 30 at. %. Beginning with equiatomic concentrations of Nb, the zone structure of the solid solution approaches the zone structure of NbC. The absence of particular points on the composition-property curve confirm this fact. (tr-auth)

17731 RADIATION DAMAGE IN ZnO SINGLE CRYSTALS. Vehse, W. E.; Sibley, W. A.; Keller, F. J.; Chen, Y. (Oak Ridge National Lab., Tenn.). Phys. Rev., 167: 828-36(Mar. 15, 1968). (ORNL-P-3525).

The radiation and additive colorations of Li-doped and "pure" ZnO crystals have been investigated. The radiation coloration is enhanced by the presence of Li impurity when the radiation temperature is in the range 80 to 330°K, but the additive coloration is suppressed in Li-doped specimens. The defect production rate, as measured by the increased optical absorption of the samples, is a linear function of electron irradiation intensity and decreases with irradiation energy. The energy dependence of the electron coloration suggests that the defect giving rise to the coloration is produced by the displacement of zinc ions. For a given dose of radiation, fast neutrons (>1 MeV) produce about 30 times as many defects as do energetic electrons. In irradiated crystals the coloration anneals out around 250°C, whereas in additive colored samples the annealing-out temperature is about 900°C. γ irradiation during and after annealing indicates that in both cases annealing is complete and not due only to the loss of electrons or holes from the defect center. It is concluded from the study that radiation damage in ZnO occurs primarily as a result of elastic collisions, and that the photochemical processes prevalent in alkali halides contribute very little, if any, to the damage. (auth)

17732 BOMBARDMENT-PRODUCED DEFECTS IN p-TYPE GERMANIUM AT LOW TEMPERATURES. Flanagan, T. M.; Klontz, E. E. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 167: 789-800(Mar. 15, 1968).

Lattice defects produced in nondegenerate (1 to 10 Ω cm) p-type germanium at 10°K by 1.0-MeV electrons cannot be detected electrically immediately following bombardment. Illumination by light having energy less than the band gap reveals the defects in the form of ionized donors. During ionization, the carrier concentration decreases as the sum of two exponentials, with time constants in the ratio ≈6 to 1. Subsequent thermal-annealing investigations show two recovery stages in the temperature range 40 to 70°K. These stages appear to be intimately related to the time constants for decay during illumination, with the low-temperature recovery associated with the fast component and the high-temperature recovery with the slow component. Both stages of recovery are independent of the type of impurity. Regardless of the extent of illumination, the electrical conductivity and the carrier concentration have essentially the same values they had prior to bombardment. When illuminated sufficiently long to ionize all the defects, the ionized donors become extremely susceptible to annihilation when the temperature is increased, and the situation after heating to 70°K represents true annealing. Illumination for shorter times results in some unionized defects which do not anneal upon heating to 70°K. Isochronal heating to 150°K then causes a transformation of most of the unannealed defects into a configuration which the authors call a "two-state defect," the same defect observed following irradiation at 77°K. The transformed defects break up at about 200°K. Along with the higher-temperature effects, some impurity-dependent recovery stages are noted. A model to partially account for the results is briefly discussed. (auth)

17733 SUBTHRESHOLD ELECTRON DAMAGE IN n-TYPE GERMANIUM. Chen, Y.; MacKay, J. W. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-125. Phys. Rev., 167: 745-53 (Mar. 15, 1968).

The minimum energy at which intrinsic defects resulting from electron bombardment have been detected in n-type Ge at 78°K is 360 keV. Defects referred to as subthreshold defects are produced at lower energies, but only in crystals grown in hydrogen. Heat treatment of such a crystal in either vacuum or hydrogen atmosphere at 450 to 500°C for 24 hr renders the crystal immune to subthreshold damage. This treatment does not change the electrical conductivity. Subthreshold defects have hole-trapping properties which render the measured carrier concentration highly sensitive to the intensity of the electron beam used for irradiation. The traps can be emptied completely by heating the samples at 140 to 280°K without modifying the defects. They can be refilled by a short irradiation. There is no dependence of the subthreshold-damage production rate on crystal orientation. The defects have different electrical properties and annealing behavior from those of defects produced by higher-energy electrons, suggesting that they may not involve the vacancy or interstitial. The production of subthreshold damage appears to be zero below about 40 keV. Damage rates at 78°K are larger than those at 273°K. Crystals grown in deuterium exhibit little or no damage. It is concluded that subthreshold damage is caused by a relocation of hydrogen impurity in the lattice. The surprising isotopic effect is suggestive of an ionization mechanism for relocation. The dependence of damage production rate on bombardment energy is consistent with an ionization-induced process, except that it should have a "zero-energy" threshold. Possible explanations are given to account for the apparent 40-keV threshold. (auth)

17734 HYPERFINE FIELD DISTRIBUTIONS IN $(ZrCO_2)_x(ZrFe_2)_{1-x}$ ALLOYS. Swartzendruber, L. J.; Bennett, Lawrence H. (National Bureau of Standards, Gaithersburg, Md.). J. Appl. Phys., 39: 1323-4(Feb. 1, 1968).

Moessbauer-effect measurements in the cubic Laves-phase pseudobinary magnetic alloys $(ZrCo_2)_x(ZrFe_2)_{1-x}$ yield complex spectra. Magnetization curves on these alloys have been previously reported. $ZrFe_2$, with a saturation moment at 4°K of about 1.6 μ_B per Fe atom and a Brillouin-type magnetization curve, displays a Moessbauer spectrum consisting of two six-line patterns, each with a hyperfine field of about 200 kOe. ZrFeCo has been reported to show only a quadrupole splitting at 78°K, although this is well below the Curie temperature. Resolved hyperfine splitting in this composition was observed at 78°K and at 4°K. The magnetization curves in $(ZrCO_2)_x(ZrFe_2)_{1-x}$ for $x = 0.2$, 0.4, 0.5, and 0.6 imply magnetic-moment distributions. The Moessbauer spectra for these alloys show hyperfine field distributions that are strong functions of temperature over a wide range below the Curie temperatures. Discrete static distributions of hf fields may explain the spectra, but relaxation effects cannot be ruled out. (auth)

17735 DIRECTIONAL BREAKDOWN IN NaCl CRYSTALS BOMBARDED WITH ELECTRONS. Agarbiceanu, I.; Teodorescu, I. (Gheorghe Gheorghiu-Dej Polytechnic Inst., Bucharest). Rev. Roum. Phys., 12: 927-31(1967).

The bombardment of NaCl crystals with electrons of medium energy (33.5 to 44 keV) has resulted in the appearance of the following structure types: Lichtenberg patterns, starlike figures, melting structures and dislocations. For these to be revealed, it is necessary that the electron beam density be sufficiently high in order to create, on the surface, strong electrical fields to produce electron avalanches. The directional breakdown figures obtained are almost identical with those obtained by scratching or by pressing the surface of the crystal with a sharp point. (auth)

17736 IRREVERSIBILITY IN PARAMAGNETIC SPIN SYSTEMS: FREE INDUCTION DECAY AND SPIN DIFFUSION. Borckmans, P.; Walgraef, D. (Univ. Libre, Brussels). Phys. Rev., 167: 282-8(Mar. 10, 1968).

In a recent work, the authors derived kinetic equations for the spin autocorrelation function for a paramagnetic spin system using the resummation procedure introduced by Résibois and De Leener in the framework of the statistical mechanics of irreversible processes due to Prigogine and co-workers. These equations are non-Markovian and nonlinear in the high-field, high-temperature, and Weiss-limit approximations. In the present paper, methods of approximation are given to solve such kinetic equations and are applied to the study of two important NMR problems, namely, free induction decay (FID) and spin diffusion. The general characteristics of the FID are obtained even in the lowest order of approximation owing to the resummation procedure, whereas the next higher-order correction leads to very good agreement with the experimental results given by Barnaal and Lowe. The following asymptotic form is also derived: $\Gamma(t) = (a \cos \alpha t + b \sin \alpha t)\, e^{-\beta t}$. A diffusion equation is obtained for the magnetization. From this, the diffusion coefficient is computed and is found to be in agreement with that proposed by several authors. However, consideration of higher-order corrections does not seem to explain the strong dependence on the orientation of the external magnetic field observed experimentally by Leppelmeier. (auth)

17737 METAMAGNETISM IN Eu_3O_4. Holmes, L. (Harvard Univ., Cambridge, Mass.); Schieber, M. Contract AF19(628)-3874. Phys. Rev., 167: 449-57(Mar. 10, 1968).

The magnetic properties of the metamagnet Eu_3O_4 are analyzed using molecular-field theory. For the antiferromagnetic ground state, it is assumed that linear, ferromagnetic chains of spins (Eu^{2+}) are polarized along the c axis of the orthorhombic unit cell, with neighboring chains antiparallel. The weakly magnetic ions Eu^{3+} provide an apparently inert magnetic background. Exchange constants are deduced from the paramagnetic Curie temperature $\theta_p = 5°K$ and the critical field $H_c = 2.4$ kOe. The constants for first- and second-neighbor Eu^{2+} interactions are $J_1/k \sim 0.3°K$ and $J_2/k \sim -0.02°K$, respectively. An anisotropy field of 7 kOe is derived from the transverse magnetic susceptibility at low temperatures. This value is also obtained from a magnetic dipolar sum. Theoretical estimates of the ordering temperature give $T_c \sim 5°K$, as observed. (auth)

17738 MAGNETIC EXCITATIONS IN URANIUM DIOXIDE. Cowley, R. A.; Dolling, G. (Chalk River Nuclear Labs., Ont.). Phys. Rev., 167: 464-77(Mar. 10, 1968).

The spin-wave dispersion relations have been measured in antiferromagnetic uranium dioxide by inelastic neutron-scattering techniques. The triple-axis crystal spectrometer at the C5 facility of NRU was used throughout in its constant-Q mode of operation. The dispersion relations were obtained for spin waves propagating along the main symmetry directions at 9°K, and less complete measurements were made at higher temperatures both above and below the Néel temperature. The theory of spin waves in UO_2 is developed and various models are used in attempts to deduce the exchange and anisotropy parameters from the experimental results. None of the models is completely satisfactory, because of the difficulties arising from the multidomain character of the specimen and from the strong interaction between the magnons and the phonons. A theory of this interaction is also developed, which gives quite reasonable agreement with experiment. (auth)

17739 CRITICAL ATTENUATION OF SOUND IN GADOLINIUM. Luthi, B.; Pollina, R. J. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev., 167: 488-92(Mar. 10, 1968).

Ultrasonic attenuation measurements in the vicinity of the Curie temperature are presented. Longitudinal waves along the c axis exhibit a large critical attenuation, whereas transverse waves show only a spurious attenuation peak. Along the a axis, the critical attenuation for longitudinal waves is much smaller. In a nonsymmetry direction, both longitudinal and transverse waves show large critical attenuation. All these results can be explained by assuming that the spin–phonon coupling is of the volume magnetostrictive type. For longitudinal waves propagating along either the c or the a axis, the following attenuation law for the frequency range 30 to 180 Mc and $(T - T_c)/T_c > 1 \times 10^{-3}$ is found: $\alpha \propto \omega^2 (T - T_c)^{-1.2 \pm 0.1}$. For temperatures nearer to T_c, the attenuation remains finite. Theories of this effect can account quantitatively for the frequency dependence but not for the temperature dependence. (auth)

17740 SPIN-LATTICE INTERACTION IN UO_2. II. THEORY OF THE FIRST-ORDER PHASE TRANSITION. Allen, S. J. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 167: 492-6(Mar. 10, 1968).

A theory of the first-order phase transition in UO_2 is presented and discussed in the molecular-field approximation. An isotropic nearest-neighbor exchange and local quadrupole–lattice interaction are taken as the basic interactions in the model. Interesting behavior is obtained due to the two distinct ways in which the collective ground-state degeneracy can be removed at T = 0°K: a cooperative Jahn–Teller distortion or a polarization of the sublattice magnetization by the exchange field. Depending on the relative gain in free energy obtained by these two mechanisms, one obtains four different types of behavior near the critical point: (1) a second-order transition to a distorted state with no magnetic ordering; (2) a second-order transition to a distorted state followed by a second-order magnetic transition; (3) a first-order transition yielding a discontinuous change in lattice distortion and sublattice magnetization; and (4) a second-order magnetic transition accompanied by a weak distortion. The temperature dependence of the elastic constant C_{44} is also derived. The parameters required to give a first-order transition in agreement with the measured discontinuity in sublattice magnetization and the correct behavior for C_{44} are found to be consistent with the parameters obtained from the measured spin-wave excitations. (auth)

17741 MAGNETIC ORDERING AND THE ELECTRONIC PROPERTIES OF THE HEAVY RARE-EARTH METALS. Watson, R. E. (Brookhaven National Lab., Upton, N. Y.); Freeman, A. J.; Dimmock, J. P. Phys. Rev., 167: 497-503 (Mar. 10, 1968). (BNL-11840).

The magnetic perturbation of the conduction-electron bands due to the periodic (and ferromagnetic) arrays of 4f moments, occurring in the heavy rare-earth metals, has been estimated from nonrelativistic augmented-plane-wave energy-band results for Tm. The relationship between these perturbations, the ordering period, and other observables, such as the c-axis resistance anomalies, are inspected. Important to these considerations and to an understanding of the ordering of the 4f moments is the magnitude of the perturbation effects, which result in sizable gaps relative to the bandwidth in the 5d bands, destroy large segments of Fermi surface (primarily normal to the c axis), and force appreciable redistributions of the populated conduction-electron states. (auth)

17742 RELATION BETWEEN THE HYPERFINE MAGNETIC FIELDS AND SUBLATTICE MAGNETIZATIONS IN Fe_3O_4. van der Woude, F.; Sawatzky, G. A.; Morrish, A. H. (Univ. of Manitoba, Winnipeg). Phys. Rev., 167: 533-5 (Mar. 10, 1968).

The temperature dependences of the hyperfine magnetic fields at ^{57}Fe nuclei in A and B sites of Fe_3O_4 have been determined with the Moessbauer-effect technique. A comparison with neutron-diffraction data shows that the H_{hpf} versus T curves follow the sublattice-magnetization versus temperature curves very closely. Over the temperature range 300 to 800°K, the hyperfine constants for A and B sites in Fe_3O_4 change less than 1%. (auth)

17743 ELECTRON INTERACTION IN RARE-EARTH METALS. Kim, D. J. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 167: 545-50 (Mar. 10, 1968).

From a unified point of view various aspects of the s-f (s-d) exchange interaction in the ferromagnetically spin-ordered states of rare-earth metals are discussed, such as (1) the indirect Ruderman–Kittel–Kasuya–Yosida type exchange interaction between localized 4f spins, (2) the spin-wave spectrum of the localized spins, and (3) the interaction between conduction electrons mediated by the exchange of spin waves of the localized spins. The present problem is very similar to that of the electron–phonon interaction in metals, and to obtain the electron–electron interaction, a similar method of using a canonical transformation is employed. The electron interaction obtained leads to a repulsion between electrons of opposite spins at the same atomic site in the vicinity of the Fermi surface. The self-energy due to this effective electron interaction is calculated for a simplified model, and the possibility of an appreciable enhancement of the specific heat is discussed. (auth)

17744 FERMI SURFACE AND ANTIFERROMAGNETISM IN EUROPIUM METAL. Andersen, O. Krogh (Technical Univ., Lyngby, Denmark); Loucks, T. L. Phys. Rev., 167: 551-6 (Mar. 10, 1968). (IS-1694).

The Fermi surface of europium was calculated in order to find those features that determine the wave vector of the helical moment arrangement below the Néel point. Two pieces of Fermi surface are found: an electron surface at the symmetry point H, which has the shape of a rounded-off cube, and a hole surface at the point P, which is also a rounded-off cube (half the size of the one at H) but with ellipsoids tetrahedrally positioned on four of the corners. It is proposed that the wave vector of the helical moment arrangement is fixed by the separation between opposing faces of the nearly cubical part of the hole surface at P, and the effects of the electron surface at H are discussed. Since it is likely that barium and europium have similar Fermi surfaces, several extremal areas and the corresponding de Haas–van Alphen frequencies are presented in the hope that experimental results may soon become available. (auth)

17745 MOESSBAUER-EFFECT STUDY OF ELECTRONIC RELAXATION IN THE PARAMAGNETIC COMPOUND $NH_4(Fe, Al)(SO_4)_2 . 12H_2O$. Campbell, L. E.; DeBenedetti, S. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 167: 556-63 (Mar. 10, 1968).

The Moessbauer spectra of paramagnetic ferric compounds exhibit magnetic hyperfine splittings when the electronic-relaxation rates of the ferric ions are made comparable to the precession frequency of the nucleus in the hyperfine field. This was observed in ferric ammonium alum diluted in aluminum ammonium alum, $NH_4(Fe,Al)(SO_4)_2 \cdot 12H_2O$, as a function of iron concentration, temperature, deuteration, and external magnetic field. The effect was also observed in the corresponding potassium alums. The crystalline-field levels of the ferric ion consist of three Kramers doublets, and each doublet produces its own hyperfine pattern. In the absence of an external magnetic field, the spectrum due to the $S_z = \pm 5/2$ doublet was completely resolved, that due to the ±0 doublet partially resolved, and that due to the $\pm 1/2$ doublet not resolved at all. Relaxation-time estimates are made ranging from $\approx 10^{-7}$ to $\approx 10^{-10}$ sec depending on the concentration, the temperature, and the particular Kramers doublet under consideration. The magnetic field produced at the nucleus by the $\pm 5/2$ doublet was found to be -572 ± 7 kG. The isomer shift is 0.53 ± 0.1 mm/sec, and the quadrupole-interaction energy, $1/4\ e^2qQ$, is equal to 0.055 ± 0.025 mm/sec. (auth)

17746 THERMOLUMINESCENCE OF NATURAL QUARTZ IRRADIATED BY GAMMA RAYS. Ichikawa, Yoneta (Nara Univ. of Education, Japan). Jap. J. Appl. Phys., 7: 220-6 (Mar. 1968).

The present investigation was undertaken to explore the gamma irradiation effect on natural quartz by thermoluminescence. Glow curves of the samples irradiated by γ rays were observed for various doses at the temperature 50 ~ 500°C and were resolved into four component peaks, B_1, B_2, C and D. The nature of defects responsible for each peak was determined by comparison with glow peaks resulting from the samples to which Li^+, Na^+ and Al^{3+} were added by the diffusion at 1000°C. As the results, the defects responsible for the B_2 and the C peaks were due to the disturbed network in the vicinity of the Li^+ and the Na^+ respectively, and the B_1 peak was associated with the aluminum center, and the defect for the D peak was due to oxygen vacancy. Increase and decrease of the B_1 peak height for the doses were related to the enhancement of the B_2 peak and the D peak, respectively. (auth)

17747 DENSITY OF STATES FOR TRANSITION METALS. I. ISOCHROMAT SPECTROSCOPIC INVESTIGATION OF bcc TRANSITION METALS. Merz, H.; Ulmer, K. (Univ., Karlsruhe, Ger.). Z. Phys., 210: 92-110 (Feb. 5, 1968). (In German).

X-ray isochromats of the bcc transition metals Ti, V, Cr, Zr, Nb, Mo, Hf, Ta, W have been measured with high resolution and under comparable conditions. These curves show, that the rigid-band-model is valid for these metals within one row of the periodic table. The width of the conduction band grows from the 3d to the 5d row. These results of the isochromat measurements are compared with conclusions about the density of states at the Fermi level, calculated from values of the electronic specific heat, magnetic susceptibility, and superconducting transition temperature. A comparison with theoretical band calculation shows, that a lowered value of the exchange term in the potential would bring into better agreement the widths of the conduction band, taken from calculation and from isochromat measurements. (auth)

17748 DEFINITION OF RELAXATION AND CORRELATION TIME IN NUCLEAR MAGNETIC RESONANCE EXPERIMENTS. Noack, F.; Held, G. (Univ., Stuttgart). Z. Phys., 210: 60-9 (Feb. 5, 1968). (In German).

Kubo's general definition of relaxation and correlation times in magnetic spin systems, applicable to nonexponential processes, is evaluated for several nonexponential relaxation and correlation functions known from NMR experiments. The new definition eliminates the arbitrary factors usually encountered in the time constants of nonexponential irreversible processes. For the correlation time of well-known "translational two-spin model," three different values are used in the literature; the definition developed here leads to $\tau_t = (1/5)(d^2/D)$ (d = distance of closest approach between the two spins, D = diffusion coefficient of the related molecules), which is an intermediate value to the conventional abbreviations $\tau_t = (1/2)(d^2/D)$ and $\tau_t = (1/6)(d^2/D)$. (auth)

17749 DIRECT DETECTION OF ^{19}F NUCLEAR ACOUSTIC RESONANCE IN ANTIFERROMAGNETIC $RbMnF_3$. Melcher, R. L. (Washington Univ., St. Louis); Bolef, D. I.; Stevenson, R. W. H. Phys. Rev. Lett., 20: 453-6 (Feb. 26, 1968).

The increase in ultrasonic attenuation as the externally applied magnetic field was swept through the value corresponding to the ^{19}F nuclear resonance in a single crystal of antiferromagnetic $RbMnF_3$ was successfully detected. The coupling of energy to the ^{19}F nuclear spin system from longitudinal ultrasonic waves propagating along the [100] axis was measured as a function of direction of applied field, frequency, acoustic power, and temperature. Separate measurements were made of the conventional NMR absorption in a second crystal of $RbMnF_3$. (W.D.M.)

17750 OPTICAL STUDY OF ELECTRONIC STRUCTURE OF GRAPHITE. Sato, Yoshiki (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Jap., 24: 489-92 (Mar. 1968).

Reflectance spectra of pyrolytic graphite are measured in the range 0.13 to 0.006 eV. The results are analyzed by a Kramers–Kronig relation to determine the complex dielectric constant $\epsilon(\omega) = \epsilon_1 + i\epsilon_2$ and energy loss function. Structures in ϵ_2 are all identified with interband transitions between the doubly degenerate levels at the points K and H of the Brillouin zone split by the effect of spin–orbit interaction. From the above fact, the strength of the coupling λ and the band parameter Δ are estimated as 0.004 eV (at the point K) or 0.0023 eV (at the point H) and –0.016 eV, respectively. Two peaks observed in $-\mathrm{Im}\ \epsilon^{-1}$ are interpreted as plasma frequencies of free electrons at the Fermi surface perpendicular and parallel to the crystallographic c axis. (auth)

17751 THE EVALUATION OF MATRIX ELEMENTS OF THE HIGH-RESOLUTION NMR SPIN-COUPLING HAMILTONIAN USING A DIGITAL COMPUTER. Pan, Yuh-kang; Rogers, Max T. (Michigan State Univ., East Lansing). J. Comput. Phys., 2: 27-31(Aug. 1967). (COO–1385-11).

The calculation of matrix elements of the NMR spin Hamiltonian between basic state wavefunctions is one of the preliminary steps for the detailed analysis of high-resolution NMR spectra. A new method for evaluating the matrix elements is proposed. The mechanics of the matrix elements is described, and the operation of the computer for calculating the coefficients of the spin coupling constants is given. The extension of the method to larger spin systems is considered. (D.L.C.)

17752 ELECTRON SPIN RESONANCE OF F CENTRES IN IRRADIATED ^{43}CaO AND OTHER ALKALINE EARTH OXIDES. Tench, A. J.; Nelson, R. L. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 92: 1055-63(Dec. 1967).

The de Boer model for the F center in CaO was confirmed by paramagnetic resonance measurements on polycrystalline samples enriched with ^{43}CaO; the isotropic and anisotropic hyperfine interactions were found to be 9.1 and 1.0 g, respectively. The hyperfine lines were also measured for the F center in neutron-irradiated BaO, and isotropic interactions of 75.5 and 86.3 g were obtained for ^{135}Ba and ^{137}Ba, respectively; the anisotropic interactions were close to 5 and 6 g, respectively. The F-center hyperfine parameters are compared for the alkaline earth oxides using a point-ion-lattice model. (auth) (UK)

17753 POLARIZATION OF SPINS BY HOT ELECTRONS IN A QUANTIZING MAGNETIC FIELD. Zvezdin, A. K. Sov. Phys.-Solid State (Engl. Transl.), 9: 1843-9(Feb. 1968).

Translated from Fiz. Tverd. Tela, 9: 2354-63(Aug. 1967).

The polarization of electronic and nuclear spins in a quantizing magnetic field caused by passing a strong electric current through the sample is investigated. A method for finding the distribution of electrons in spin sublevels for an arbitrary distribution in "kinetic" degrees of freedom is considered. An equation is obtained, which connects the increase in nuclear polarization with the parameters of the hot-electron distribution function. The polarization of electronic spins in the ultraquantum limit is calculated, while allowing for spin scattering by acoustic and optical phonons. The theory is compared with experiment. (auth)

17754 RADIATION-STIMULATED MIGRATION PROCESSES IN SOLIDS. Kiv, A. E.; Umarova, F. T. (Inst. of Nuclear Physics, Ulugbek, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 1745-8(Feb. 1968).

Translated from Fiz. Tverd. Tela, 9: 2225-9(Aug. 1967).

One of the possible mechanisms of radiation-stimulated diffusion in solids is considered: acceleration of the diffusion by elastic scattering of particles on diffusing atoms. Dependences are derived, which make it possible to detect experimentally the investigated mechanism. (auth)

17755 LINE SHAPE FOR THE CHARACTERISTIC ENERGY LOSSES OF ELECTRONS IN SOLIDS. Rumyantsev, V. V. (Leningrad Polytechnical Inst.). Sov. Phys.-Solid State (Engl. Transl.), 9: 1860-6(Feb. 1968).

Translated from Fiz. Tverd. Tela, 9: 2377-86(Aug. 1967).

The problem of line shape for the maxima in the energy spectrum of electrons scattered in solids with characteristic energy losses is discussed. From a consideration of the graphs representing the polarization operator, an allowance for Landau attenuation, electron "viscosity," and electron–phonon interactions, the shape of the characteristic-loss line is determined when the resonance frequency corresponding to the characteristic energy lies outside the optical absorption region. It is shown that there is a characteristic dependence of the height of the corresponding characteristic peaks on the energy of the incident particle. (auth)

17756 DECELERATION OF SLOW HYDROGEN AND DEUTERIUM IONS IN A THIN SILVER FOIL. Gott, Yu. V.; Tel'kovskii, V. G. Sov. Phys.-Solid State (Engl. Transl.), 9: 1741–4(Feb. 1968).

Translated from Fiz. Tverd. Tela, 9: 2221–4(Aug. 1967).

The results are reported of measurements of the specific energy losses of 0.2- to 40-keV hydrogen and deuterium ions in silver. It is shown that the experimental results obtained are in satisfactory agreement with theoretical predictions. (auth)

17757 APPLICATION OF THE MOESSBAUER EFFECT TO THE STUDY OF FERRITES AND DIELECTRICS. Belov, V. F.; Zheludev, I. S. (Inst. of Crystallography, Moscow). At. Energy Rev., 5: No. 4, 3-30(1967).

Results of studies on the Moessbauer effect in ferrites with garnet and spinel structures, and also in various dielectrics, are reviewed. Using ferroelectrics and ferromagnetics as examples, it is shown that the Moessbauer effect may be successfully used in phase transition studies. In the phase transition region the probability of the Moessbauer effect shows anomalous characteristics connected with the anomalous temperature dependence of the frequency of the optical branch of the crystal lattice vibrational spectrum. Along with quadrupole splitting, a magnetic hyperfine structure of the Moessbauer spectra is observed in ferromagnetics, which disappears on transition to the paramagnetic state. In the region of the Curie ferroelectric temperature a sharp change occurs in the chemical shift in $BaTiO_3$ and $Pb(Fe_{0.5}Nb_{0.5})O_3$, indicating a change in the ionic character of the chemical bond. The review quotes the results of studies which do not fit in with these mechanisms. Considering as a concrete example single crystals of tourmaline, opportunities are cited for application of the Moessbauer effect in elucidating structural problems. An important aspect of ferromagnetism is the nature of the magnetic fields at the nuclei. The review gives the results of investigations of Moessbauer spectra in iron garnets and spinels. Analysis of experimental data on the magnetic fields at the nuclei of these compounds shows that the strength of the magnetic field depends on the magnetic moment of the ions, the local environment, and the number and nature of the exchange bonds. In iron garnets account must also be taken of the degree of covalency of the chemical bond and of the deviation of the lattice symmetry from the cubic. The occurrence of magnetic fields at diamagnetic atoms of tin in the lattice of an yttrium iron garnet is described. Magnetic fields at iron nuclei are normally due to the ion's own electrons. In the case of tin, however, the magnetic field is created by polarization of the electron shell of a diamagnetic atom by the magnetic moment of iron atoms through indirect exchange interaction. 77 references. (auth)

17758 MOESSBAUER-EFFECT STUDY OF ERBIUM SPIN RELAXATION IN MAGNETICALLY ORDERED COMPOUNDS. Zinn, W. (Forschungslaboratorium der Siemens AG, Munich); Wiedemann, W. J. Appl. Phys., 39: 839-41(Feb. 1, 1968).

The ^{166}Er hyperfine fields, Er^{3+} magnetic moments, and electronic spin correlation times in ferromagnetic erbium–aluminum intermetallic structures have been studied between 1.5 and 80°K using the Moessbauer effect of the 80.6 keV gamma rays of ^{166}Er. The spin correlation times deduced from both the rate equation model and the Wegener formula follow approximately a T^{-1} temperature dependence below T_C. Above T_C the spin correlation times of about 5×10^{-11} sec decrease by nearly an order of magnitude and are found to be rather sensitive to the distinct assumptions made on the electronic ground-state multiplet and attributed S_z distribution function in the different theoretical approaches. (auth)

17759 EXCITATION OF NUCLEAR AND ELECTRONIC SPIN WAVES IN $RbMnF_3$ BY PARALLEL PUMPING. Hinderks, Larry W.; Richards, Peter M. (Univ. of Kansas, Lawrence). J. Appl. Phys., 39: 824-5(Feb. 1, 1968).

Observation of the simultaneous excitation of nuclear and electronic spin waves by parallel pumping, an effect predicted by Ninio and Keffer, is reported in $RbMnF_3$ at a pumping frequency of 8.56 GHz. Wave-vectors between near zero and 10^5 cm^{-1} are excited by varying H. This work is done with H and h_{rf} in a [100] direction and H greater than the value required for flopping. From threshold fields, which are about 1.2 Oe minimum it is calculated that, at 4.2°K, $\eta_k^n \eta_k^e = 6.1 \times 10^{10}$ sec^{-2} for $k \rightarrow 0$ and 9.5×10^{10} sec^{-2} for $k = 1.05 \times 10^5$ cm^{-1} (n stands for nuclear mode, e for electronic). These figures are smaller by two orders of magnitude than what is obtained from η_k^e inferred by Cole and Courtney from saturation of the main resonance and the value of η^n taken from the half-width of NMR absorption. To reduce critical-field data to spin-wave line-widths the methods of Ninio and Keffer were applied to obtain a theoretical expression for h_{crit} in the case of a flopped antiferromagnet. (auth)

17760 MOESSBAUER EFFECT IN ^{57}Fe IN COPPER AND THE SPIN-COMPENSATED STATE. Schwartz, B. B. (Massachusetts Inst. of Tech., Cambridge); Kim, D. J.; Frankel, R. B.; Blum, N. A. J. Appl. Phys., 39: 698-9(Feb. 1, 1968).

The results of Moessbauer experiments on dilute Fe in Cu in high external magnetic fields (42 to 146 kOe) are presented here as evidence for significant destruction of the spin-compensated state by a magnetic field for which $\mu H_0 \sim kT_K$, where kT_K is on the order of the energy change associated with the formation of the spin-compensated state. (auth)

17761 NUCLEAR RELAXATION RATES IN SINGLE-DOMAIN COBALT. Kaplan, N. (Univ. of California, Santa Barbara); Jaccarino, V.; Lewis, R. T. J. Appl. Phys., 39: 500-2(Feb. 1, 1968).

Recent studies indicate that the "intrinsic" nuclear spin-lattice relaxation rate, $1/T_1$, in the domains of bulk ferromagnetic metals is obtained only when an external field H_{ex} is applied which exceeds the demagnetizing field and no walls remain. This has motivated the present work, on small, single-domain Co particles with the following results: (1) At low fields and at all temperatures between 1.3 and 300°K a very strong field dependence of T_1 is found; T_1 appears to be constant when $H_{ex} \gtrsim 4$ kOe. (2) At all temperatures $1/T_1$ decreases monotonically with increasing particle size. (3) Studies above 4 kOe show that, unlike in the bulk, T_1T is not constant. However, $(d/dT)(1/T_1)$ approaches a constant value for $T \gtrsim 60$°K which is independent of particle size. This is indicative of a contribution to the relaxation rate, not present in the bulk particles, arising from paramagnetic-like surface atoms that are exchange-coupled either to each other or to the cobalt host. No effects of superparamagnetism were found even for the smallest (~110 Å) particles. (auth)

17762 ENHANCED SUSCEPTIBILITIES AND NMR RELAXATION RATES IN Co–Rh ALLOYS. Walstedt, R. E.; Sherwood, R. C.; Wernick, J. H. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 39: 555-6(Feb. 1, 1968).

Dilute alloys of Co in Rh show a weakly temperature-dependent susceptibility increase $\Delta\chi(\mathrm{Co}) \sim 20 \times 10^{-4}$ emu/mole of Co solute as compared with $\chi \sim 1 \times 10^{-4}$ emu/mole for pure Rh. This effect is thought to be associated with Coulomb enhancement of the d-electron spin susceptibility in the neighborhood of the Co impurity. By plotting the ^{59}Co NMR shift vs $\Delta\chi(\mathrm{Co})$ one finds an effective core-polarization hyperfine field considerably smaller than that of Co metal. Spin-echo double-resonance studies of these alloys show that the nearest-neighbor ^{103}Rh nuclei to the Co impurity undergo a negative NMR shift of ~0.56% relative to the bulk ^{103}Rh nuclei. The origin of this shift is not clearly understood. In particular, attributing such a shift to d-spin polarization is not consistent with the short-range polarization effects expected. Measurements of T_1 and T_2 show strongly enhanced hyperfine field fluctuations at the ^{59}Co nucleus, presumably due to local Coulomb interactions. $T_1T = 39.5$ msec°K and $T_2T = 3.0$ msec°K for temperatures ranging from 1.2 to 20.4°K are found. The discrepancy between T_1 and T_T (spin lattice) is apparently a consequence of strong first-order quadrupolar broadening of the ^{59}Co Zeeman levels for $|m| > 1/2$. (auth)

17763 ^{57}Fe HYPERFINE FIELDS IN DILUTE Pd–Fe ALLOYS. Skalski, S.; Budnick, J. I.; Lechaton, J. (Fordham Univ., Bronx, N. Y.). J. Appl. Phys., 39: 965-6(Feb. 1, 1968).

The ^{57}Fe hyperfine field distribution was studied in an alloy of 0.5 at. % Fe in Pd by NMR spin-echo spectroscopy at temperatures between 1.3 and 4.2°K. The Fe spectrum at 4.2°K is asymmetric. The asymmetry decreases and the frequency of the maximum increases as the temperature is lowered so that at the lowest temperature the Fe line is essentially symmetric about a value corresponding to a field of −299.7 kOe. The interpretation of this data in terms of an enhanced RKKY spin polarization model is presented. The temperature dependence of the maximum is fitted to a $T^{3/2}$ law and a value of 34°K Å^2 for the acoustic spin-wave stiffness constant in this alloy is obtained. (auth)

17764 RESTORATION OF MOTIONALLY NARROWED HYPERFINE SPLITTING IN SUPERPARAMAGNETIC PARTICLES BY MAGNETIC FIELD. Eibschutz, M.; Shtrikman, S. (The Weizmann Inst. of Science, Rehovoth, Israel). J. Appl. Phys., 39: 997-8(Feb. 1, 1968).

Moessbauer absorption spectra of ^{57}Fe in ultrafine powders of $NiFe_2O_4$ were taken in external magnetic fields from 0 to 20 kOe at room temperature. A transition from a spectrum with no hyperfine field, H_{hpf}, to a Zeeman split spectrum of $H_{hpf} = 500$ kOe has been observed. Comparison of the results with magnetization measurements suggests that the drastic effect of the external field is due to the polarization of the superparamagnetic particles by the field. (auth)

17765 MOESSBAUER SPECTRA OF ^{57}Fe IN SUPERPARAMAGNETIC NICKEL. Lindquist, R. H. (Chevron Research Co., Richmond, Calif.); Constabaris, G.; Kundig, Walter; Portis, A. M. J. Appl. Phys., 39: 1001-3(Feb. 1, 1968).

The Moessbauer effect is used to study the superparamagnetic behavior of ultrafine particles of nickel dispersed on a high-area substrate. In zero applied field, a characteristic hyperfine spectrum is observed at 78°K. As the sample is warmed to room temperature, the spectrum narrows to a single line as the result of rapid fluctuations in the magnetization direction. A fluctuation time of the order of 2 nsec is indicated from the room-temperature data. With the application of a magnetic field the hyperfine spectrum is developed at room temperature. Although it is not possible to assign a single relaxation time to the magnetic-field data, there is some indication that the fluctuations are slowed by the application of an external magnetic field. (auth)

17766 MOESSBAUER STUDIES ON THE SUPERPARAMAGNETIC BEHAVIOR OF MAGNESIOFERRITE PRECIPITATES. Gonser, U.; Wiedersich, H.; Grant, R. W. (North American Aviation Science Center, Thousand Oaks, Calif.). J. Appl. Phys., 39: 1004-5(Feb. 1, 1968).

Moessbauer spectroscopy has been used to study the superparamagnetic properties of small ferrimagnetic $MgFe_2O_4$ domains coherently precipitated in a MgO lattice. Different average sizes of precipitates were obtained by varying the annealing temperature and time. A technique is described to estimate the average particle size and relaxation time for the thermal reorientation of the net magnetization from the Moessbauer data. (auth)

17767 MOESSBAUER STUDY OF $FeCl_2 . 4H_2O$ IN THE TEMPERATURE RANGE 4.2° TO 0.025°K. Ono, K.; Shinohara, M.; Ito, A.; Fujita, T.; Ishigaki, A. (Tokyo Univ.). J. Appl. Phys., 39: 1126-7(Feb. 1, 1968).

The Moessbauer spectrum of ^{57}Fe in $FeCl_2 \cdot 4H_2O$ has been examined in the temperature range 4.2 to 0.025°K. The temperature dependence of the internal magnetic field indicates that the spin ordering starts at 1.3°K. The spectrum below the Néel temperature is well-explained with the parameters $H = 266$ kOe, $e^2qQ/2 = 3.10$ mm/sec, $\eta = -0.2$ and $\angle Hq = 25°$, where H, $e^2qQ/2$, and η have the conventional meanings and $\angle Hq$ is the angle between the internal magnetic field and the electric field gradient at the iron nucleus. The spectrum for a single crystal with gamma rays being parallel to the monoclinic crystal axis b determines $\angle Hb = 15°$. Thus, below the Néel temperature the directions of the internal magnetic field at the two sites of iron nuclei in this material make an angle of 30° with each other. (auth)

17768 SATELLITE LINES IN THE ^{59}Co RESONANCE IN COBALT–NICKEL ALLOYS. Riedi, P. C.; Scurlock, R. G. (Univ. of Southampton, Eng.). J. Appl. Phys., 39: 1241-2(Feb. 1, 1968).

The distribution of effective field at the ^{59}Co nucleus in alloys of composition Co_cNi_{1-c} was studied for $c \geqslant 0.93$, using an automatic swept frequency spin-echo NMR spectrometer at 4.2°K. Three satellite lines were observed displaced approximately 7.5 MHz, 15 MHz, and 22 MHz below the main line at 217.4 MHz. The intensities of the satellite lines relative to the main line are in good agreement with the probabilities of configurations with one, two, and three nickel atoms respectively in the near-neighbor shell. A further partially resolved satellite 2 MHz below the main line was also observed and attributed to nuclei with one nickel atom in the next-nearest neighbor shell and none in the first-neighbor shell. From these measurements it is concluded that the magnetic disturbance produced by a nickel atom in the cobalt lattice is well localized, in agreement with the neutron-diffraction measurements. (auth)

17769 INTERNAL FIELDS AT THE TWO SITES OF THE SPINEL SYSTEM $Ni_{1+x}Ge_xFe_{2-2x}O_4$ BY MOESSBAUER EFFECT. Fatseas, G. A.; Krishnan, R. (CNRS, Meudon, France). J. Appl. Phys., 39: 1256-7(Feb. 1, 1968).

In the study of ferrites, some authors have found two Moessbauer resonances of Fe^{3+} in tetrahedral (A) and octahedral (B) sites. The lower value of the internal field at the nucleus of Fe^{3+} in A sites has been attributed to the dipolar field, resulting from deviations from cubic symmetry, and to the more covalent nature of iron–oxygen bonds. When the A site behaves as a perfect tetrahedron, the quadrupole interaction being absent, the dipolar field is excluded and the decrease in the field H_A can be attributed to the effect of covalence alone. Those requirements are fulfilled in the spinel system $Ni_{1+x}Ge_xFe_{2-2x}O_4$. No quadrupole interaction is evident in any of these spectra. The lower value of H_A in all cases is attributed to the covalent effects in $Fe^{3+}-O^{2-}$ bonds in A sites. The variation of H_A and H_B with x at 300°K is shown to be the effect of Curie temperature. At 80°K H_B is independent of x, whereas H_A decreases with an increase in x. This diminution in H_A is attributed to the modification brought about by the presence of Ge^{4+} in A sites making the $Fe^{3+}-O^{2-}$ bonds more covalent. This hypothesis is supported by the lower isomer shift of A sites. (auth)

17770 FORMATION OF F CENTERS IN ALKALINE EARTH OXIDES BY PLASTIC DEFORMATION. Bessent, R. G. (Atomic

Energy Research Establishment, Harwell, Eng.); Feltham, P. Phys. Status Solidi, 25: K107-10(Feb. 1, 1968).

The main EPR spectrum of unirradiated CaO and SrO single crystals was that of Mn^{2+} impurity with, in some cases, a very weak F center. After reactor irradiation to a dose of 1.6×10^{17} nvt with fast neutrons, the optical absorption spectra showed a prominent band attributed to the F center. Plastic deformation of unirradiated crystals by rolling a steel wristwatch gear wheel over the crystal surface did not result in increase of the weak F-center EPR signal. After x irradiation at room temperature, clear F-center signals were obtained from the indented crystals, while parallel irradiation produced no significant change in unindented crystals. The F-center wavelengths of these oxides do not conform to an Ivey-type power law. It is suggested that a hydrogenic model of the F-center electron might hold reasonably well. (A.G.W.)

17771 IRRADIATION DECORATION OF DEFECTS IN SINGLE-CRYSTAL BeO. Smith, D. K.; Newkirk, H. W. (Univ. of California, Livermore). Phys. Status Solidi, 25: K79-82(Feb. 1, 1968).

Flux-grown BeO crystals were irradiated in a reactor to a total neutron dosage of 1×10^{20} nvt (>1 MeV) and studied by optical microscopy, x-ray diffraction, and electron-beam microanalysis. All crystals, to varying degrees, showed the presence of decorations along an axial screw dislocation running the length of the inner core of the crystal and along the twin boundary separating this inner core from the surrounding sheath. Unirradiated control crystals showed no decoration. It is concluded that the twin boundaries and screw dislocations must be revealed by decoration by helium or tritium gas bubbles from the transmutation of ^{9}Be and ^{18}O. (A.G.W.)

17772 COLOR CENTERS IN PLASTICALLY DEFORMED ALKALINE EARTH FLUORIDES. Feltham, P.; Ghosh, R. (Brunel Univ., London). Phys. Status Solidi, 25: K71-3(Feb. 1, 1968).

Strains of up to several percent were induced in CaF_2 and BaF_2 crystals by compression in air in the ranges 300 to 500 and 150 to 300°C, respectively. The crystals were then x-irradiated in the dark either in air or liquid nitrogen for up to 50 hr. No coloration resulted. Other crystals of CaF_2, BaF_2, and SrF_2 were deformed by diamond pyramid indentations and then x-irradiated for several hours. Coloration similar to additive coloration (pink in CaF_2, green in SrF_2, and blue in BaF_2) resulted in all cases. Irradiation of an indented CaF_2 crystal containing several ppM of Mn showed enhanced colorability compared with the pure crystal, and the indentations were violet. (A.G.W.)

17773 FERMI SURFACES OF TUNGSTEN AND MOLYBDENUM. Herrmann, R. (Humboldt Univ., Berlin). Phys. Status Solidi, 25: 661-6(Feb. 1, 1968). (In German).

The absolute values of the electron effective masses in tungsten and molybdenum are compared. For the same orbits of the Fermi surface the ratio of effective masses in molybdenum and tungsten is 1.3 : 1. The metals show different deviations from the theoretical model of the Fermi surface. So the resonance corresponds in tungsten to an octahedral surface but in molybdenum to a spherical surface. (auth)

17774 DIFFUSION IN INERT-GAS BOMBARDED KCl, KBr, AND KI. Kelly, R. (McMaster Univ., Hamilton, Ont.); Jech, C.; Matzke, Hj. Phys. Status Solidi, 25: 641-53(Feb. 1, 1968).

A study of inert-gas diffusion, mainly involving Kr and Xe, in ion-bombarded KCl, KBr, and KI was made using bombardment energies up to 85 keV and doses up to 50 μA min/cm^2. Two types of release behavior were observed, both of which were shown to be compatible with diffusion kinetics, at least to first approximation. Low doses led to release with a fairly well defined ΔH of 33.5, 30.5, and 28.5 kcal/mole for KCl, KBr, and KI respectively, while high doses led to release with a somewhat variable ΔH having mean values of 44, 39, and 33.5 kcal/mole for KCl, KBr, and KI, respectively. It is proposed that the low-dose release involves gas motion without an implied gas–gas or gas–damage interaction, the gas perhaps occupying small stable vacancy clusters. The high-dose release seems to be affected by transient gas–gas or gas–damage interactions, and is probably identical with the process found in homogeneous-labeling work between about 250°C and the knee temperature. A third type of release, found in homogeneous-labeling work above the knee temperature has no parallel in ion-bombardment work. It is here tentatively attributed to the motion of small, gas-filled bubbles, and its ΔH of 7 to 14 kcal/mole is proposed to be related to that for surface diffusion of the host crystal. (auth)

17775 INVESTIGATION OF GRAIN-BOUNDARY ENERGETICS IN Er_2O_3 THIN FOILS BY TRANSMISSION ELECTRON MICROSCOPY. Murr, L. E. (Univ. of Southern California, Los Angeles). Phys. Status Solidi, 25: 629-40(Feb. 1, 1968).

The oxidation of erbium thin films directly within the electron microscope, and the subsequent grain growth and equilibration of the Er_2O_3 foils have allowed the true dihedral angles at grain boundary triple junctions to be calculated. It is observed that a mean dihedral angle of 120° obtains for these oxide-ceramic films; and the comparison of the three-dimensionally computed dihedral angles with the two-dimensional angles measured directly from electron-microscope images of grain boundary triple junctions in Er_2O_3 exhibited a uniqueness that questions the necessity of three-dimensional corrections for this particular property. The distribution of relative grain boundary free energy ratios in Er_2O_3 foils is also calculated; and the spread of this data is interpreted to represent the effects of the relative grain orientations composing a triple junction. The mean boundary inclination is observed to be 71.1°, which suggests an influence on grain-boundary equilibrium in thin foils of surface image forces. The results generally indicate that the application of techniques previously utilized in the study of metallic grain-boundary energetics is equally valid in certain oxide-ceramic thin films. (auth)

17776 ATTENUATION LENGTH OF PHOTOELECTRONS IN THIN FILMS OF URANIUM. Lea, C.; Mee, C. H. B. (Univ. of Southampton, Eng.). Phys. Status Solidi, 25: 613-19(Feb. 1, 1968).

Films of uranium up to about 1000 Å thick were evaporated on to quartz substrates at pressures less than 5×10^{-10} torr. The attenuation length L of photoelectrons in the films was estimated by comparing the photoelectric emission current when the film was illuminated from the vacuum side (i_1) to that when the film was illuminated from the substrate side (i_2). Theory indicates a linear relationship between log (i_1/i_2) and thickness, and this was confirmed by experiment for illumination with light of photon energies from 3.5 to 5.0 eV. The constants of the relationship yield values for L between 60 and 120 Å, the attenuation length decreasing with increasing photon energy. Measurements of the electrical conductivity of the films as a function of thickness yielded a value for the mean free path of the conduction electrons of about 290 Å. The results suggest that the principal energy-loss mechanism for the excited electrons is one of electron–electron scattering. (auth)

17777 MOESSBAUER INVESTIGATIONS OF Mg, Mn, AND MgMn FERRITES IN EXTERNAL MAGNETIC FIELDS. Wieser, E. (Zentralinstitut fuer Kernforschung, Berlin); Povitskii, V. A.; Makarov, E. F.; Kleinstueck, K. Phys. Status Solidi, 25: 607-11 (Feb. 1, 1968).

The Moessbauer spectra of six Mn, MgMn, and Mg ferrites were measured with a transversal and longitudinal external magnetic field. The line shifts make possible the coordination of the internal fields with octahedral and tetrahedral sites and confirm especially the deviations from the Néel model predicted for the MgMn ferrites. From the polarization effects in the longitudinal field it is seen that existing deviations from the Néel model could be only in the form of oppositely directed spins within the sublattices. (auth)

17778 INVESTIGATION OF ACTIVE CRYSTAL LENGTH IN FLOW REGIONS OF NEUTRON-IRRADIATED COPPER SINGLE CRYSTALS. I. FORMATION OF SLIP BANDS. Neuhaeuser, H. (Univ., Munich). Phys. Status Solidi, 25: 593-606(Feb. 1, 1968). (In German).

Electron microscopic and cinematographic studies show that the slip bands within the Lüders band of a neutron-irradiated copper single crystal consist of several slip lamellae, which form one after another in the course of slip band formation. The strain within these lamellae develops to a good approximation homogeneously, and is accomplished in a rather short time (e.g., $\approx 10^{-1}$ sec at room temperature with a crosshead speed of 10^{-3} mm/sec). The structure and development of the slip bands as a function of crosshead speed, temperature, and neutron dose are explained qualitatively as due to the concurrence of the cutting process and cross slip of the gliding dislocation. (auth)

17779 ATOMIC ^{3}H CENTER IN NEUTRON-IRRADIATED LiF. Kazumata, Y. (Japan Atomic Energy Research Inst., Tokyo). Phys. Status Solidi, 25: 563-6(Feb. 1, 1968).

LiF crystals irradiated with neutrons at 80°K are investigated by electron spin resonance measurements. A paramagnetic center due to atomic tritium is observed. The center decays at 350°C. (auth)

17780 ELECTRON MICROSCOPY OF HIGH-TEMPERATURE Nb_2O_5 AND RELATED PHASES. Allpress, J. G.; Sandirs, J. V.; Wadsley, A. D. (Commonwealth Scientific and Industrial Organization, Melbourne). Phys. Status Solidi, 25: 541-50(Feb. 1, 1968).

Crystals of high-temperature niobium pentoxide (HNb_2O_5) and some mixed niobium–tungsten oxide phases were examined by transmission electron diffraction and microscopy. The diffraction patterns and images of lattice fringes are fully consistent with the previously reported structures determined by x rays from the same samples. Irregularities in the lattice fringes, caused by faulting, were very rare in HNb_2O_5, but common in the mixed oxide phases. (auth)

17781 ACOUSTICAL SATURATION OF THE NMR LINE OF ^{115}In IN InSb. Vladimirtsev, Yu. V.; Golenishchev-Kutuzov, V. A.; Shamukov, N. A.; Aver'yanov, I. S. (Physico-technical Inst., Kazan). Sov. Phys.-Solid State (Engl. Transl.), 9: 1899-1900(Feb. 1968).

Translated from Fiz. Tverd. Tela, 9: 2426-8(Aug. 1967).

Acoustical saturation at twice the Larmor frequency of the NMR signal of ^{115}In in InSb at 77°K was investigated. It was found that the NMR signal amplitude decreased in proportion to the square of the applied acoustical power. From this relationship, the spin–phonon interaction constant was determined. The dependence of the NMR signal on the frequency of the sound is also shown, and an explanation is proposed for the fact that the width of the acoustical resonance line is three times the width of the magnetic resonance. (A.G.W.)

17782 CHANGE IN THE LATTICE CONSTANT OF LITHIUM FLUORIDE·SINGLE CRYSTALS DUE TO X-RAY IRRADIATION. Golubeva, L. A.; Smiryagina, S. A.; Shishelov, A. A. (Kalinin Polytechnic Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 9: 1897-8(Feb. 1968).

Translated from Fiz. Tverd. Tela, 9: 2424-6(Aug. 1967).

Previously obtained experimental data on the change in the lattice constant of LiF single crystals during x irradiation are analyzed. An equation describing the relationship between the lattice-constant change and the radiation dose is given, and the concentration of F centers is calculated from the lattice-constant change. It is concluded that the change consists of two stages: a fast change associated with transitions of Mg^{2+} impurity ions from lattice sights when fluorine is ionized, and a slow change due to formation of Frenkel defects at the expense of anions. (A.G.W.)

17783 SHAPE ON NMR LINE FOR A TWO-SPIN AND NON-RESONANT-DIPOLE SYSTEM. Moiseev, B. M.; Fedorov, L. I. (All-Union Scientific-Research Inst. for Mineral Deposits, Moscow). Sov. Phys.-Solid State (Engl. Transl.), 9: 1867-8(Feb. 1968).

Translated from Fiz. Tverd. Tela, 9: 2387-9(Aug. 1967).

The presence of magnetic dipoles in the crystal lattice has a substantial effect on the shape of the NMR line of a two-spin system. The NMR absorption spectra of two nuclei are investigated in the case when these nuclei and the nearest magnetic dipole are situated on the vertices of an isosceles triangle. Expressions are obtained for the line shape function of such a system for a polycrystalline sample in the case when the nonresonant dipole takes the form of a nuclear magnetic moment or the mean magnetic moment of a paramagnetic ion. (auth)

17784 CHANNELING OF ALPHA PARTICLES IN BERYLLIUM OXIDE. Garber, R. I.; Fedorenko, A. I. (Physical-Technical Inst. of Low Temperatures, Kharkov). JETP Lett. (USSR) (Engl. Transl.), 6: 293-5(Nov. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 851-3(Nov. 1, 1967).

The fast-particle source used in the experiment was Pu-239, which emits 5.15-MeV α particles. The targets for the study of α-particle penetration were made of amorphous of polycrystalline BeO in the form of plates 0.5 mm thick. When the integral dose of bombarding particles was increased, the channeling efficiency dropped. The displaced lattice atoms and the penetrating helium atoms distort the structure of the channels in the BeO crystal. This leads to an overall decrease of the transparency of the crystal to fast particles, as is indeed observed in the experiments. (M.H.R.)

17785 INVESTIGATION OF THE MOESSBAUER EFFECT IN A SOLID SOLUTION OF BARIUM STANNATE IN BARIUM TITANATE. Belov, V. F.; Zheludev, I. Z. (Inst. of Crystallography, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 287-93(Nov. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 843-5(Nov. 1, 1967).

The Moessbauer effect in the region of the ferroelectric phase transition from the paraelectric into the ferroelectric state is investigated in the solid solution $BaTi_{0.75}Sn_{0.25}O_3$ of barium stannate in barium titanate. The samples were prepared by a standard ceramic method. The dielectric constant was measured by a bridge method at 2000 Hz. The Moessbauer spectra of the investigated samples were obtained with a setup of the electrodynamic type. (M.H.R.)

17786 ACTION OF IONS OF MEDIUM ENERGY IN THIN FILMS. Baltzinger, Christiane; Goldsztaub, Stanislas; Perey, Marguerite (Centre de Recherches Nucleaires, Strasbourg. Faculte des Sciences, Strasbourg). Compt. Rend., Ser. A and B, 266: 18-20(Jan. 3, 1968). (In French).

Monocrystalline films several-hundred angstroms thick and with orientation {001} of pure gold, pure copper, and ordered gold–copper alloys were bombarded at room temperature under normal incidence by H^+, N_2^+, and Ne^+ ions with energies between 30 and 100 keV. The modification of the structure and the texture of these films were observed by diffraction of fast electrons. (tr-auth)

17787 INTERACTION OF IMPURITY TIN IN TRANSITION-METAL MATRICES. Chekin, V. V.; Vinnikov, A. P.; Afanas'ev, V. I. (Physical-Technical Inst. of Low Temperatures, Kiev). JETP Lett. (USSR) (Engl. Transl.), 6: 216-17(Oct. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 743-5(Oct. 1, 1967).

The isomer shift of ^{119m}Sn nuclei was measured in Au, Ag, Cd, In, Pb and Cu. (M.O.W.)

17788 RADIO-FREQUENCY SIZE EFFECT IN MOLYBDENUM. Boiko, V. V.; Gasparov, V. A.; Gverdtsiteli, I. G. (Physical-Technical Inst., Sukhumi, USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 212-14(Oct. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 737-41(Oct. 1, 1967).

The samples investigated had a resistance ratio $R_{300°K}/R_{4.2°K}$ = 12,000 and were in the form of discs 6 mm in diameter and 0.142 mm thick. They were placed in the coil of the generator tank circuit and were cooled together with the coil to helium temperatures. The experiment consisted of measuring $\partial R/\partial H$ as a function of H. (M.O.W.)

17789 MOESSBAUER EFFECT OF IRON SELENIDES WITH THE STRUCTURE NiAs. Fatseas, Georges A. (Centre National de la Recherche Scientifique, Bellevue, France). Compt. Rend., Ser. A and B, 265: 1073-6(Nov. 13, 1967). (In French).

The Mössbauer absorption spectra reveal the existence of two different sites for the atoms of Fe in the compounds $Fe_{1-x}Se$ of structure of B 8_1. Their electronic configuration is discussed as a function of the isomeric displacement and of the internal field. (tr-auth)

17790 CONCERNING THE ANOMALIES OF THE ELECTRONIC PROPERTIES OF RARE-EARTH METALS. Kaganov, M. I.; Finkel, V. A. (Physico-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.), 6: 315-16(Nov. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 881-3(Nov. 1, 1967).

Studies of the crystal structure of rare earth metals in the magnetically ordered state have revealed maxima on the plots of atomic volume against temperature (at T_{max} ~ 200°K for Gd, 210°K for Tb, and 145°K for Dy). These maxima are connected with the different temperature dependences of the periods of the hexagonal close-packed lattices. At approximately the same temperatures, anomalies were observed in a number of physical properties: specific magnetization, electric resistivity, thermal emf, etc. This note suggests that these anomalies may be the consequence of a change in topology of the Fermi surface, resulting from the intersection of this surface with the boundaries of the first Brillouin zone. (L.M.T.)

17791 MAGNETIZATION MEASUREMENTS AND PRESSURE DEPENDENCE OF THE CURIE POINT OF THE PHASE Sc_3In. Gardner, W. E. (Atomic Energy Research Establishment, Harwell Eng.); Smith, T. F.; Howlett, B. W.; Chu, C. W.; Sweedler, A. Phys. Rev., 166: 577-88(Feb. 10, 1968).

The approximate composition limits of the Sc_3In phase have been determined as 22 to 23 at. % In. Susceptibility measurements have been made on a number of alloys, containing various amounts of the Sc_3In phase in the compositional range 21 to 26 at. % In. Heat and mechanical treatments reveal a critical dependence of the magnetic properties on the degree of order of the Sc_3In phase. Although the susceptibility varies inversely with temperature, this behavior is not considered to be evidence for the presence of localized moments, since the magnetic moment per Sc atom is much smaller than that associated with $S = 1/2$, and does not agree with the value obtained from the magnetization data as a function of magnetic field. Initial susceptibility measurements, below the Curie temperature, exhibit structure which suggests that a strong magnetocrystalline anisotropy may exist at temperatures close to T_c. The pressure dependence of the Curie point has been determined as $\partial T_c/\partial P = 1.95 \times 10^{-4}$ °K bar^{-1}. (auth)

17792 THE RATIO OF THE LARMOR FREQUENCY OF ^{189}Os RELATIVE TO ^{1}H. Schwenk, A.; Zimmermann, G. (Univ., Tuebingen, Ger.). Phys. Lett., 26A: 258-9(Feb. 12, 1968).

The frequency of the nuclear magnetic resonance of ^{189}Os relative to ^{14}N was measured and referred to that of the proton: $\nu^{189}\mathrm{Os}/\nu^1\mathrm{H} = 0.0776562 \pm 0.0000005$. The magnetic moment of ^{189}Os and the ratio of the magnetic moments of ^{189}Os and ^{187}Os were evaluated. (auth)

17793 NUCLEAR SPIN RELAXATION AND DYNAMIC POLARIZATION VERSUS ELECTRON SPIN–SPIN RELAXATION. Borghini, M. (CERN, Geneva). Phys. Lett., 26A: 242-4(Feb. 12, 1968).

The spin–spin relaxation of paramagnetic centers in dielectric solids may act as a cause of nuclear spin relaxation or dynamic polarization, according to the case. (auth)

17794 RECOVERY IN STAGE I OF BERYLLIUM IRRADIATED BY NEUTRONS AND BY ELECTRONS. Nicoud, J. C.; Bonjour, E.; Schumacher, D.; Delaplace, J. (Centre d'Etudes Nucleaires, Grenoble, France). Phys. Lett., 26A: 228-9 (Feb. 12, 1968). (In French).

The release of the energy stored in beryllium after neutron and electron irradiation was measured between 27 and 77°K. The recovery behavior is-essentially the same in both cases and in agreement with earlier electric resistivity measurements. (auth)

17795 DIELECTRIC THEORY OF INELASTIC ELECTRON SCATTERING INTO CRYSTAL REFLECTIONS. Morys, P.; Schoenebeck, H. (Technische Univ., Berlin). Z. Phys., 210: 314-18(1968). (In German).

Inelastic energy losses of free electrons (20 to 100 keV) scattered into crystal reflections were theoretically investigated. By extending the usual dielectric theory of solids to crystals these scattering processes can be explained as an immediate scattering into the reflections. The probability of scattering for an electron with a fixed energy loss is derived. This result agrees in the case of a homogeneous medium with the probability of scattering already known within the frame of the usual dielectric theory. (auth)

17796 NEUTRON DEPOLARIZATION MEASUREMENT ON Dy NEAR MAGNETIC TRANSITION POINTS. Rauch, H.; Loffler, E. (Osterreichische Hochschule, Vienna). Z. Phys., 210: 265-75 (1968). (In German).

It is possible to determine the dimensions of the ferromagnetic correlation range by depolarization measurements of polarized thermal neutrons near magnetic transition points, where small magnetic domains ($<10^{-4}$ cm) are present. The dimensions of the magnetic domains of Dy were determined in the temperature range from 4.2°K to room temperature and in an external magnetic field from 0 to 2.4 kOe. The size of the domains increases with decreasing temperature and increasing external field. For low temperatures a sort of internal coercive force for the wall mobility was observed, which strongly hinders the formation of greater ferromagnetic domains. At the Curie-point the ferromagnetic correlation range shows a continuous transition and goes only slowly to zero when the temperature increases. (auth)

17797 TOTAL REFLECTION OF THE RECOILLESS 8.4-keV γ RAYS OF ^{169}Tm. Wagner, Friedrich E. (Technische Hochschule, Munich). Z. Phys., 210: 361-79(1968). (In German).

The total reflection of the recoilless 8.4-keV γ-radiation of ^{169}Tm was observed at various glancing angles between 3 and 7 milliradians on surfaces of Tm metal and Tm_2O_3 produced by vacuum evaporation. The Mössbauer velocity spectra of the reflected intensity show a typical dispersion pattern due to interference between electronic and nuclear resonant scattering, which can be understood quantitatively, thus permitting the determination of the nuclear scattering amplitude. From this the total conversion coefficient of the 8.4-keV transition was derived to be $\alpha = 220 \pm 50$. (auth)

17798 PROMPT AND DELAYED FLUORESCENCE OF X-RAY-EXCITED ANTHRACENE CRYSTALS. Perkins, W. G. (Sandia Corp., Albuquerque, N. Mex.). J. Chem. Phys., 48: 931-8(Jan. 15, 1968).

The fluorescence of anthracene excited by x rays from a 600-keV pulsed source was investigated. An x-ray dose of 7.6×10^{12} eV cm^{-3} produced a prompt fluorescence output of 1.4×10^{11} photons cm^{-3}, as well as an intense delayed fluorescence. Analysis of the time dependence of the delayed fluorescence, based on the diffusion kinetics of triplet excitons in tracks, indicated that the above dose produced 7×10^{10} singlet excitons by direct excitation ($S_0 \rightarrow S_n$ transitions) and 2.7×10^{11} short-lived ion pairs, of which 7×10^{10} recombined to form singlet excitons and 2×10^{11} recombined to form triplet excitons. In these calculations, the value of the triplet exciton diffusion coefficient was found to be $(1 \pm 0.5) \times 10^{-4}$ cm^2 sec^{-1}. (auth)

17799 MULTIPLE-PULSE NMR EXPERIMENTS. Waugh, J. S.; Wang, C. H.; Huber, L. M.; Vold, R. L. (Massachusetts Inst. of Tech., Cambridge). Contract DA-28-043-AMC-02536-(E). J. Chem. Phys., 48: 662-70(Jan. 15, 1968).

The behavior of a spin system disturbed by a train of closely spaced pulses can, under the proper limiting circumstances, be described in terms of a time-independent effective Hamiltonian. The necessary conditions on pulse spacing are discussed and a recipe is given for constructing the effective Hamiltonian. The method is applied to the previously employed trains of 180° or 90° pulses, obtaining the well-known limiting behavior for small pulse spacing. An analysis is given of a recently reported experiment using a train of phase-alternated 90° pulses. Two new experiments involving complex pulse sequences are proposed, one of which permits the arbitrary scaling of the effective chemical shifts in a high-resolution NMR spectrum, and the other of which annihilates dipole–dipole and quadrupole effects in solids, leaving the chemical shifts and scalar couplings. (auth)

17800 MAGNETIC STRUCTURES OF $TbAu_2$. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys., 48: 560-4(Jan. 15, 1968).

Neutron-powder-diffraction study has shown that, in the range 55° to 42.5°K, $TbAu_2$ (tetragonal, isostructural to $MnAu_2$) exhibits a linear-transverse-wave spin alignment propagating along the a axis (the face-centered description) and polarized in the c-axis direction. The wavelength of this static magnetization wave is incommensurable with the atomic repetition and varies from 1.200 to 1.186 in a spacing units in the range 55° to 42.5°K. The rms moment per Tb at 42.6°K is 5.1 Bohr magnetons. At just below 42.5°K, a first-order magnetic transition takes place and the wavelength of the transverse wave abruptly becomes equal to the a spacing. The resulting antiferromagnetic structure persists down to 2°K and the saturation moment is practically identical to the ordered moment of the free Tb^{3+} ion, 9.0 Bohr magnetons. The crystallographic data in the range 300° to 5°K are also presented. (auth)

17801 THERMAL DIFFUSION FLUX EQUATION FOR ZIRCONIUM HYDRIDE AT HIGH HYDROGEN CONTENTS. Barsell, A. W. (Atomics International, Canoga Park, Calif.). J. Chem. Phys., 48: 544-8(Jan. 15, 1968).

The thermal diffusion mechanism for hydrogen in zirconium is studied in terms of a simple kinetics model appropriate for nondilute as well as dilute solutions. The equations resulting from this model are correlated with available experimental data for zirconium hydride at high hydrogen contents. The results demonstrate that the thermal diffusion flux term for a concentrated solution must contain a factor to account for the nonavailability of interstitial sites. This factor is essentially proportional to the probability of an individual atom finding a vacant site on an adjacent lattice in which to jump. For δ- or ϵ-phase zirconium hydride, this factor is given with reasonable accuracy by $(2-H/Zr)/3.25$. (auth)

17802 OPTICAL SPECTRA OF Nd^{3+} IN SINGLE CRYSTALS OF SCANDIUM AND YTTRIUM OXIDES. Zverev, G. M.; Kolodnyi, G. Ya.; Smirnov, A. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 325-7(Oct. 1967).

Translated from Opt. Spektrosk., 23: 606-10(Oct. 1967).

A scheme of the Stark splitting of the $^4I_{9/2}$, $^4I_{11/2}$, and $^4F_{3/2}$ terms of neodymium in Sc_2O_3 and Y_2O_3 based on the investigation of the absorption and luminescence spectra of Nd^{3+} in these lattices at 4.2, 77, and 293°K is proposed. The lifetime of the $^4F_{3/2}$ level was measured. (auth)

17803 CALIBRATION OF THE ^{57}Fe ISOMER SHIFT. Simanek, E.; Wong, Andrew Y. C. (Univ. of California, Los Angeles). Phys. Rev., 166: 348-9(Feb. 10, 1968).

The s-electron density at the iron nucleus in $KFeF_3$ is calculated as a function of the Fe-F distance, using the Heitler–London model and the Hartree–Fock ionic wave functions. By comparing the calculated "overlap-induced" s-electron density with the hydrostatic pressure isomer shift measurements in $KFeF_3$, the relative change of the ^{57}Fe nuclear radius is found to be -5.2×10^{-4}, which is to be compared with the value -1.8×10^{-3} derived previously by Walker et al. (auth)

17804 SPIN-LATTICE INTERACTION IN UO_2. I. GROUND-STATE AND SPIN-WAVE EXCITATIONS. Allen, S. J. Jr. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 166: 530-9(Feb. 10, 1968). (TID-23945).

A microscopic theory of the effect of spin–lattice interaction on the ground-state and spin-wave excitations in UO_2 is presented. Three parameters required by a Jahn–Teller description of the local spin–lattice interactions and an exchange constant are introduced as basic variables to describe the system at T = 0°K. The spin–lattice ground state reveals a competition between the Jahn–Teller forces and the exchange energy that results in a reduction of the magnitude of the spin. It is also shown that the indirect quadrupole–quadrupole interaction caused by the virtual exchange on an optical phonon is as large as the exchange coupling (~30°K), and significantly modifies the spin-wave energies and wave functions. Values for the interaction parameters are obtained by fitting the theory to the excitation spectra and to wave functions deduced from far-infrared absorption spectroscopy and from the inelastic scattering of neutrons. The theory is consistent with the upper limits placed on the lattice distortion and with the anomalous behavior of the elastic constant C_{44}. (auth)

17805 MODULATION AND CROSS-RELAXATION EFFECTS ON THE LINE SHAPE OF STRONGLY SATURATED NUCLEAR MAGNETIC RESONANCE IN SOLIDS. Pifer, Joe H. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Phys. Rev., 166: 540-53(Feb. 10, 1968). (COO–1198-464).

The nuclear-magnetic-resonance dispersion line shape in aluminum was observed under the common experimental condition of slow passage with magnetic field modulation, while applying an rf field H_1 intense enough to produce saturation, and it was found that the line shape does not agree with the very-weak-H_1 theory of Bloembergen, Purcell, and Pound, or with Redfield's strong-H_1 theory. The line shape was qualitatively explained by assuming that the spin system in the rotating frame can be divided into two parts which have unequal temperatures, and which are able to cross-relax. For two limiting cases—large H_1 and H_1 small, but still large enough to saturate—the line shape was calculated for all modulation frequencies, and semiquantitative agreement was obtained. The small-H_1 calculation is based upon the theories of Provotorov and of Goldman. The large-H_1 theory is a phenomenological extension of Redfield's theory. The dipole spin-lattice relaxation time and the cross-relaxation time were measured by observing the signal as a function of modulation frequency. This method has the advantages of both the signal-to-noise ratio of steady-state resonance, and the measurement of time on a frequency scale. (auth)

17806 MOESSBAUER-EFFECT DETERMINATION OF CRYSTALLINE ELECTRIC FIELD SPLITTINGS IN SEVERAL INTERMETALLIC COMPOUNDS OF THULIUM. Uhrich, D. L.; Genin, D. J.; Barnes, R. G. (Ames Lab., Iowa). Phys. Rev., 166: 261-8(Feb. 10, 1968). (IS–1670).

By measuring the temperature dependence of the nuclear quadrupole splitting of the ^{169}Tm 8.4-keV Mössbauer γ transition, a measure of the strength of the crystalline electric field (CEF) in several hexagonal intermetallic compounds of the type TmX_2, where X is another transition element, has been obtained. As in thulium metal, a zero-order model of the CEF incorporating only the C_2^0 parameter is found sufficient to describe the experimental results. On this basis, the over-all CEF splitting of the $^3H_6$ ground term of the Tm^{3+} ion is found to be 94 cm^{-1} in $TmRu_2$, 88 cm^{-1} in $TmRe_2$, and 42 cm^{-1} in $TmMn_2$. The nuclear and ionic shielding parameters R_Q and σ_2 were also determined from the experimental measurements, in reasonable agreement with theoretical expectations. Best agreement between experimental and calculated values of the CEF parameters is obtained when the effective charge on the X ions is taken to be zero. Details of the calculation of the CEF parameter C_2^0 by the plane-wise summation method for the hexagonal Laves-phase intermetallic are also given. (auth)

17807 MAGNETIC SUSCEPTIBILITY AND NUCLEAR MAGNETIC RESONANCE STUDIES OF TRANSITION-METAL MONOPHOSPHIDES. Scott, B. A.; Eulenberger, G. R.; Bernheim, R. A. (Pennsylvania State Univ., University Park). J. Chem. Phys., 48: 263-72(Jan. 1, 1968).

The magnetic susceptibilities of the transition-metal monophosphides TiP, ZrP, HfP, VP, NbP, TaP, and CrP were measured between 78° and 400°K. Susceptibilities ranged from -0.70×10^{-6} cgs/g for TaP to 3.4×10^{-6} cgs/g in CrP. Although small temperature variations of χ were observed in some cases, magnetic ordering was absent in these materials over the temperature range investigated. Shifts of the ^{31}P magnetic resonance relative to 85% H_3PO_4 were all to higher frequency (lower applied field) for the Group IVa and Va monophosphides, and temperature-independent, varying from 0.001% in HfP to 0.059% for TiP. On the other hand, the ^{31}P resonance in CrP exhibited an indirect Knight shift of K(297°K) = −0.149%, which varied linearly with bulk magnetic susceptibility. From K(T) vs χ (T) data a value of -30 ± 3 kOe/Bohr magneton was obtained for the phosphorus hyperfine field in CrP. Metal resonance shifts and quadrupole splittings were also measured in ^{51}VP and ^{93}NbP. Magnetic susceptibility results are shown to be consistent with the qualitative features of Goodenough's model in which narrow cation d bands lie in the energy gap between broad metal–phosphorus valence and conduction bands. The NMR findings in CrP and the isomorphic compounds MnP, FeP, and CoP studied by previous workers suggest appreciable covalent mixing of phosphorus $3d_\pi$ states with cation t_{2g} sublattice bands, and support the concept that the e_g states are collective in the monophosphides. (auth)

17808 ELASTIC MODULI AND ULTRASONIC ATTENUATION OF POLYCRYSTALLINE EUROPIUM FROM 4.2 TO 300°K. Rosen, M. (Atomic Energy Commission, Beer-Sheva, Israel). Phys. Rev., 166: 561-4(Feb. 10, 1968).

The longitudinal and transverse acoustic velocities and the ultrasonic attenuation of high-purity polycrystalline europium metal have been measured by a pulse technique between 4.2 and 300°K. The variations with temperature of the Young modulus E, shear modulus G, adiabatic compressibility K, and Debye temperature θ_D, have been determined. The Néel point at 91°K is marked by drastic changes in the elastic moduli and ultrasonic attenuations. Anomalies in the attenuation and in the compressibility are observed at about 150°K. The limiting value of θ_D is 117°K. (auth)

17809 MAGNETIC AND CRYSTALLOGRAPHIC CHARACTERISTICS OF PRASEODYMIUM HYDRIDES. Wallace, W. E.; Mader, K. H. (Univ. of Pittsburgh). J. Chem. Phys., 48: 84-9 (Jan. 1, 1968).

The susceptibilities (χ) and lattice parameters are reported for a series of praseodymium hydrides represented by the formula PrH_x in which x varies from 0.99 to 2.57. χ was measured from 4° to 300°K and at field strengths up to 21 kOe. The samples are two-phase for $x \leq 1.85$. Curie–Weiss behavior is observed for all samples above 100°K with slopes in fairly good agreement with that expected for an assemblage of free tripositive ions. Deviations occur below 100°K. These are two kinds—negative for $x < 2.1$, and positive for $x > 2.1$. The deviations in the first case are small and appear to result from the crystal-field interaction. The positive deviations are ascribed to a change of valence for Pr from 3+ to 4+. Magnetic, electrical, and crystallographic evidence is in accord with this postulate. There is no indication of magnetic ordering in the hydrides at 4.2°K. (auth)

17810 EFFECT OF ELECTRIC-FIELD-GRADIENT INHOMOGENEITY ON QUADRUPOLAR SATELLITE INTENSITIES IN NUCLEAR MAGNETIC RESONANCE SPECTRA IN SOLIDS. McCart, B. R.; Barnes, R. G. (Ames Lab., Iowa). J. Chem. Phys., 48: 127-31(Jan. 1, 1968). (IS–1633).

A simple model of random electric-field-gradient inhomogeneity has been incorporated into the usual first-order treatment of quadrupolar satellites in nuclear magnetic resonance spectra in solids. Observed departures of experimental intensities from those expected strictly on the basis of transition probabilities are satisfactorily accounted for on the basis of this model. (auth)

17811 URANIUM MONOSULFIDE. THE FERROMAGNETIC TRANSITION. THE HEAT CAPACITY AND THERMODYNAMIC PROPERTIES FROM 1.5° TO 350°K. Westrum, Edgar F. Jr. (Univ. of Michigan, Ann Arbor); Walters, Robert R.; Flotow, Howard E.; Osborne, Darrell W. Contract AT(11-1)-1149. J. Chem. Phys., 48: 155-61(Jan. 1, 1968). (COO–1149-93).

The heat capacity of uranium monosulfide was measured from 1.5° to 22°K by an isothermal (isoperibol) method and from 6° to 350°K by an adiabatic technique. The ferromagnetic transition at 180.1°K has a characteristic lambda shape and associated magnetic ordering entropy and enthalpy increments of $1.6_2 \pm 0.2$ cal°K^{-1} mole^{-1} and 231 ± 20 cal mole^{-1}, respectively, over the temperature range 0° to 230°K. The correlation of the thermal data with magnetic studies is discussed. The heat capacity below 9°K is represented by $C_p = 5.588 \times 10^{-3}T + 2.627 \times 10^{-4}T^{3/2} + 6.752 \times 10^{-5}T^3$ cal °K^{-1} mole^{-1}, in which the successive terms represent conduction electronic, magnetic, and lattice contributions. Values of the entropy [S°], enthalpy function [$(H^\circ - H_0^\circ)/T$], and Gibbs-energy function [$(G^\circ - H_0^\circ)/T$] are 18.64 ± 0.05, 8.94 ± 0.02, and -9.70 ± 0.02 cal °K^{-1} mole^{-1}, respectively, at 298.15°K. The Gibbs energy of formation at 298.15°K is -72.9 ± 3.5 kcal mole^{-1}. (auth)

17812 ANOMALOUS ENERGY LOSSES OF 1.5-MeV PROTONS CHANNELED IN SILICON SINGLE CRYSTALS. Mannami, M. (Kyoto Univ.); Fujimoto, F.; Ozawa, K. Phys. Lett., 26A: 201-2(Jan. 29, 1968).

The ⟨110⟩-channeling effect in the energy loss of 1.5-MeV protons for silicon single crystals of various thicknesses is investigated. The results seem to support the Lindhard proposal for the importance of the equipartition rule. (auth)

17813 ANOMALY IN THE MAGNETIC SUSCEPTIBILITY OF YTTRIUM. Gardner, W. E.; Penfold, J. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 26A: 204-6(Jan. 29, 1968).

A maximum in the magnetic susceptibility of high-purity polycrystalline yttrium has been observed at about 300°K. A comparison of the magnetic properties of yttrium and palladium shows a number of remarkable similarities. (auth)

17814 LATTICE DEFECTS AND THEIR INTERACTIONS. **Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967. 1150p. $35.00 Professional Edition, $68.00 Reference Edition.**

Thirty articles on the nature and interactions of defects in crystal lattices are included. Separate abstracts were prepared for fifteen articles. (A.G.W.)

For abstracts of individual papers see: 17350 and 17815–17828.

17815 ENERGIES AND ATOMIC CONFIGURATIONS OF LINE DEFECTS AND PLANE DEFECTS IN FCC METALS. **Cotterill, R. M. J.; Doyama, M. (Argonne National Lab., Ill.). pp 1-78 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.**

Atomistic models and the central force approximation have been used in calculations of the atomic arrangements and energies of line and plane defects in pure fcc metals. The atoms were treated as discrete particles and the minimum energy configuration for each defect was determined by iteration with the aid of a digital computer. The stacking-fault energies of copper and aluminum were determined for various interatomic potential functions. The best fit with experimental data was obtained with Harrison's pseudopotential for aluminum, which gives 253 ergs cm^{-2}. This result is a first approximation because the local modification of the potential caused by the stacking fault is neglected. Born–Mayer and Morse potential functions do not in general give good stacking-fault energies; but a value of 30 ergs cm^{-2} for copper is obtained by use of a Morse potential, which is truncated in a self-consistent fashion at 176 neighboring atoms. In the calculation of the complete edge and screw dislocations, the atoms were not permitted to relax in the directions parallel and perpendicular to the dislocation line respectively. This prevented dissociation. Linear elasticity is found to break down inside a core radius of 9 Å for a complete ⟨112⟩ edge dislocation in copper. The corresponding core energy is 0.65 eV per {112} plane. For the screw dislocation in copper the core radius is 5.3 Å and the core energy is 1.0 eV per {110} plane. The complete edge dislocation in copper was found to have a width of 13 Å, while the screw dislocation in the same material has a width of 5 Å. In neither case is the core region hollow nor like a liquid. If the constraint against atomic relaxations in the directions enumerated earlier are removed, the dislocations dissociate spontaneously with no activation energy. Surface energies for the {111}, {100}, and {110} surfaces in aluminum, copper, and gold have been obtained with Morse potentials whose constants were derived in such a way that the correct vacancy formation energies are obtained. In each case the {111} surface has the lowest energy, while the {100} surface energy is about 5 to 10% higher and the {110} surface energy is nearly 20% higher. The {111} surface energies in aluminum, copper, and gold were found to be 473, 951, and 572 ergs cm^{-2} respectively. The atom layers at the surface are found to be more outwards by a few per cent of the interplanar spacing. (auth)

17816 ENERGIES AND ATOMIC CONFIGURATIONS OF POINT DEFECTS IN FCC METALS. **Doyama, M.; Cotterill, R. M. J. (Argonne National Lab., Ill.). pp 79-165 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.**

Discrete atom calculations of the energies and atomic configurations of point defects have been carried out using a central force approximation. Point defects and point defect clusters were examined with the aid of a digital computer. The pairwise interaction between atoms was represented by a Morse potential function truncated at 176 neighboring atoms. The truncation was made in such a way that the potential still gave the correct bulk crystal properties and also consistency with the Born stability criteria. A variational method was used to obtain the equilibrium configurations of each defect. Single vacancies, divacancies, trivacancies, and tetravacancies were examined. The activation energies of formation, binding, and migration were obtained. The four possible trivacancies and three of the possible tetravacancies were studied. The absolute values of formation energy may not be particularly reliable because effects such as the redistribution of electrons around the defects have been ignored. Moreover, the Morse function is only an approximation of the true interatomic potential. The migration energies of divacancies and trivacancies are quite similar. The rhombic tetravacancy was found to be the most stable arrangement of four vacancies. In this configuration the four vacancies lie in a single 111 plane and five nearest-neighbor bonds are involved. The tetrahedral tetravacancy (bounded by four 111 planes, with six nearest-neighbor bonds) was found to be metastable. The relaxations of the atoms surrounding the rhombic tetravacancy are such as to indicate that collapse of the vacancy cluster onto a single 111 plane occurs even when there are only four vacancies in the cluster. The rhombic form might therefore be regarded as a nucleus for collapsed vacancy loops. Six different types of single interstitials were examined. These were the split-100, the split-110 (or crowdion), the split-111, the body-centered, the tetrahedral, and the activated crowdion. Of these, only the split-100 is stable, all the others being unstable. The formation energy of the split-100 type was found to be approximately 3.6 eV, and the associated volume change is 1.3 atomic volumes. The energies of the other types when they are artifically prevented from degenerating are greater than that of the split-100 by amounts in the range 0.1 to 0.3 eV. The order of increasing energy is split-100, split-110, body-centered, split-111, and tetrahedral. (auth)

17817 INTERACTION OF INTERSTITIALS WITH SOLUTE ADDITIONS IN FACE-CENTERED CUBIC METALS. **Sosin, A. (North American Aviation Science Center, Thousand Oaks, Calif.). pp 233-66 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.**

A survey is made of the experimental observations that pertain to the interaction between interstitial atoms and foreign solute atoms in copper and aluminum. Consideration is limited to the number of substages introduced into the recovery spectrum of the electrical resistivity by solute atom additions and an analysis of the magnitude of one particular substage in the system Cu(Au) as a function of gold concentration. These considerations are then related to the atomic configuration of solute atom and interstitial, emphasizing the importance of the form of the interstitial. (auth)

17818 LATTICE DEFECTS AND FLUORINE MOTION IN LaF_3. **Sher, A.; Solomon, R.; Lee, K.; Muller, M. W. (Varian Associates, Palo Alto, Calif.). pp 361-405 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.**

The temperature dependence of the thermal expansion, fluorine nuclear magnetic resonance, and electrical conductivity of single-crystal LaF_3 in the temperature range 300 to 1000°K exhibits several striking features. The observed phenomena appear to be associated with the formation of Schottky defects and with the diffusion of fluorine ions. The activation energy for the formation of defects in the lower portion of this range has the unusually low value of ~0.07 eV. The activation energy for fluorine-ion diffusion is ~0.45 eV below the Debye temperature and appears to decrease above this temperature. The results of the measurements can be correlated by means of a tentative thermodynamic model of the crystal, which postulates the formation of neutral defects and a dissociation equilibrium for these defects. The thermal behavior of the transport properties is ascribed to local distortions of the spectrum of lattice vibrations associated with the defects. (auth)

17819 X-RAY TOPOGRAPH EXAMINATION OF VACANCY CLUSTERS IN NEARLY PERFECT COPPER CRYSTALS. **Young, F. W. Jr.; Baldwin, T. O.; Sherill, F. A. (Oak Ridge National Lab., Tenn.). pp 543-65 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.**

Vacancies present at temperatures near the melting point in nearly perfect 99.999% copper crystals with dimensions of order centimeters cluster upon cooling the crystal, and the clusters are visible as black spots in Borrmann x-ray topographs. Phenomenological evidence that the black spots correspond to some form of vacancy cluster is presented. The diffraction contrast of the black-spot images has been examined in a series of 111, 220, 200 and 222 topographs taken with Ag, Mo, Cu, and Cr $K_{\alpha 1}$ radiation. Some of the images show the proper contrast for prismatic dislocation loops. Many of the images appear in all topographs. Images of defects that intersect the exit surface for the x rays show a black–white contrast, which can be interpreted in terms of vacancy loops. It is concluded that the evidence from diffraction contrast supports the assumption that the black spots correspond to vacancy clusters of various forms. (auth)

17820 DAMAGE RATE MEASUREMENTS IN PLATINUM AND OTHER METALS BY ELECTRON IRRADIATION. **Bauer, Walter (Atomic International, Canoga Park, Calif.). Contract AT(11-1)-gen-8. pp 567-90 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.**

The results of the rate of defect introduction in platinum by electron irradiation and a perspective of similar measurements on other metals are presented. Although an appreciable amount of effort has been devoted in recent years to damage-rate measurements in the near-threshold region the accumulated data have not yielded a thorough knowledge of two fundamental parameters of the displacement process — the displacement cross section and the threshold displacement energy. However, an appreciation of the various experimental difficulties and the nature of the complexity of the displacement processes near threshold has been gained. (auth)

17821 NEUTRON IRRADIATION EFFECTS SATURATION IN α-IRON. Beeler, J. R. Jr. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. pp 619-52 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.

Computer simulations of the cumulative production of defects by a sequence of overlapping collision cascades in α iron were used to study the approach to saturation of neutron-irradiation effects at 0°K. Vacancy–interstitial interaction was accounted for on the basis of the recombination region approximation. The average macroscopic displacement density was increased only by the intrusion of collision cascades into undamaged material. This occurred because the local average displacement density in a displacement spike was saturated ab initio. The saturation exposure for electrical resistivity was shown to be at least 10^2 times that for maximum irradiation hardening in pure α iron at 0°K. During the approach to the saturation of the average macroscopic displacement density, the damaged regions exhibited a preferred orientation along $\langle 110 \rangle$ directions. (auth)

17822 INTERACTIONS BETWEEN LATTICE DEFECTS IN ELECTRON IRRADIATED COPPER. Iseler, G. W.; Dawson, H. I.; Kauffman, J. W. (Northwestern Univ., Evanston, Ill.). pp 653-80 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.

The recovery of the electric resistivity between 6 and 60°K (stage I) of electron-irradiated polycrystalline 99.999% copper has been carefully reexamined. Different electron energies and doses have been used. Also, the response to prior irradiation at 78°K and to a small plastic deformation at room temperature has been studied. The overall shape of the recovery spectrum obtained in stage I does not disagree with that described in the literature. However, additional structure is observed throughout the entire range of stage I. There are groups of peaks that correspond to the peaks previously labelled I_A through I_E. The processes occurring in the I_A, I_B, and I_C ranges are still believed to be due to recombinations of Frenkel pairs. The substages observed in I_D are due to essentially first-order reactions and are also explained by close-pair recovery. The I_E substages do not shift in temperature with electron dose, but the relative maximum recovery rate of the different substages is dose-dependent. An interpretation that takes free interstitial migration in I_E into account is proposed. The detailed distribution of defects, however, remains largely uncertain. (auth)

17823 LOW TEMPERATURE RECOVERY STUDIES IN ELECTRON IRRADIATED ALUMINUM. Dawson, H. I.; Iseler, G. W.; Kauffman, J. W. (Northwestern Univ., Evanston, Ill.). pp 681-711 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.

The recovery between 6 and 60°K of electron-irradiated high-purity aluminum is described. The physical property studied was the electrical resistivity. A spectrum consisting of many substages was found. Recombinations of close interstitial–vacancy pairs cause most of the recovery in stage I. It is concluded that free interstitial migration occurs near the end of this stage. An extensive comparison is given between stage-I recovery of aluminum and copper. It appears that the behavior in this stage is very similar in these metals with regard to dose dependence, energy dependence, and the response to radiation and dislocation doping. (auth)

17824 ELECTRON IRRADIATION HARDENING. Ono, Kanji (Univ. of California, Los Angeles); Meshii, M. Contract AT(11-1)-1367. pp 713-833 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.

A general review of the theory and previous experimental work on the hardening effect of electron irradiation is followed by a report of experimental work on Al. Mechanical properties of Al single crystals were studied following 1-MeV electron irradiation at 23 and 85°K. Irradiation at 23°K produced large increases in both yield stress and extend of easy glide. No change in the slope of the easy glide was observed, and there was no sharp yield point immediately after irradiation. The yield stress increase ($\Delta\tau$) was proportional to the square root of defect concentration. When irradiated specimens were annealed in the temperature region of stage-I recovery (35 to 60°K), extensive recovery of $\Delta\tau$ and significant yield drop associated with a sharp yield point were observed. A theory based on the rate theory of deformation with a dispersed barrier model explains the magnitude of $\Delta\tau$. This conclusion is further supported by observations based on strain-rate cycling tests and annealing studies. The maximum interaction energy between an interstitial and a dislocation is estimated to be 0.7 ± 0.2 eV. The recovery during annealing at stage I is mainly due to vacancy–interstitial recombination. Toward the later part of stage I, free interstitial migration to dislocations occurs, and the interstitials attached to dislocations are thought to be responsible for the observed yield drop. Deformation characteristics indicate that hardening following irradiation at 85°K is due to interstitials that have migrated to dislocations and precipitated into the form of jogs on the dislocations. The activation energy of jog motion was found to be 0.19 eV. (auth)

17825 ROOM TEMPERATURE COLORATION OF DEFORMED KCl CRYSTALS. Sibley, W. A.; Russell, J. R. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. pp 835-54 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967. (ORNL-P-1559).

Studies of the effect of deformation on the colorability of KCl have shown that the enhanced colorability due to plastic flow of the crystals is very sensitive to impurity type and concentration. In pure samples a 2% deformation and subsequent irradiation increases the M-center production relative to that of the F center, whereas in calcium-doped specimens a large increase in F-center formation occurs. These observations imply that different types of defects are created in the two cases and so the annealing behavior of pure and doped KCl crystals was investigated. A 48-hour anneal at 25°C was not sufficient to eliminate the deformation effect in either the KCl:pure or KCl:Ca samples. However, it was possible to anneal out the coloration in doped samples by heat treating at 120°C for 10 hours. For the pure specimens it was necessary to anneal at 175°C for 10 hours in order to eliminate the color centers. The annealing results suggest that the deformation-induced colorability of crystals is not due to a simple dissociation of divalent impurities and vacancies by moving dislocations. (auth)

17826 NEUTRON-INDUCED LIFETIME DEGRADATION IN SILICON. Curtis, Orlie L. Jr. (Northrop Nortronics, Newbury Park, Calif.). pp 855-83 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.

The influence of dopant impurities and oxygen on the degradation of the carrier lifetime of silicon by neutrons was investigated. The dopants arsenic, phosphorus, gallium, and boron were utilized over a wide range of carrier concentrations in materials grown by different techniques. No dependence of the rate of lifetime degradation on impurity was observed. The reasons for the wide variation in degradation rates reported in the literature for neutron-irradiated silicon are injection-level effects and annealing effects, with injection-level effect being more important. In all cases the lifetime was strongly dependent upon injection level. To obtain exponential photoconductivity decays, excitation levels as low as 0.01% were required. Following room-temperature irradiation the samples were stored in dry ice. Measurements were performed after total time at room temperature of ~2 hours. For the conditions of these measurements the number of neutrons/cm^2 (nvt > 10 keV) required to produce 1 μ sec lifetime in initially perfect samples varied from 8.2×10^{10} for 0.5-ohm-cm n-type material to 2.1×10^{11} for 60-ohm-cm n-type material. For p-type material the required dose values of 1.1×10^{11} to 3.3×10^{11} correspond to the resistivity range 0.6 to 38 ohm-cm. (auth)

17827 DISLOCATIONS AS SOURCES AND SINKS FOR POINT DEFECTS IN METALS. Seidman, D. N.; Balluffi, R. W. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-3504. pp 911-60 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.

A wide variety of dislocation climb experiments was analyzed quantitatively with the object of determining in each case the magnitude of the maximum possible force driving climb and the ability of the dislocations to climb in response to this force. In general, the results indicate that the Frank three-dimensional dislocation network is very often capable of climbing with a high efficiency in pure metals. In the case of aluminum (a high-stacking-fault-energy metal) climb appears to be highly efficient in the presence of large to moderate driving forces. Climb in gold (a low-stacking-fault-energy metal) ranges from highly efficient to moderately efficient in the presence of large to moderate driving forces. No data are available for establishing lower limits of the climb efficiency under very small driving forces. The rather questionable climb data available for the Frank dislocation network in alloys over a wide range of driving forces indicate that climb efficiencies may be lower in alloys than in pure metals. Climb during dislocation-loop shrinkage in pure metals appears to be highly efficient. Kinetic data are needed for loop growth. A number of aspects of dislocation climb were discussed and some assessment of the present status of the climb problem was attempted. (auth)

17828 EFFECTS OF SHOCK LOADING ON THE LATTICE OF A SILICON BRONZE WITH LOW STACKING FAULT ENERGY. **Otte, H. M. (Martin Co., Orlando, Florida); Holland, J. Read. pp 1087-1144 of Lattice Defects and Their Interactions. Hasiguti, R. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.**

The effects of shock loading on the lattice of a silicon bronze with low stacking-fault energy were studied by postmortem analysis. Crystal imperfections introduced by shock loading up to 420 kbar were studied primarily by x-ray diffraction. The specimens were 30 mm long and 2 × 2 mm in cross section; the shock pressure was applied to one of the 2 × 30 mm faces. By spinning the specimens at 200 rpm about the long axis, a Debye–Scherrer geometry could be employed for the x-ray work. The macroscopic plastic strains determined from dimensional changes of the specimens varied linearly with shock pressure, whereas the slope of hardness versus pressure was initially steep and then asymptotically approached a limiting value. Analysis of the position and width of x-ray-diffraction line profiles showed: (1) some formation of "deformation" stacking faults; (2) a decrease in domain size to a lower limiting value, reached at fairly low (~100 kbar) shock pressures; (3) essentially no rms strain in any of the specimens even after loading to maximum shock pressure. The observations are consistent with the formation, by shock loading, of micro twins and faults as the principal lattice imperfections. In addition, evidence was found for a polymorphic transformation between 130 and 200 kbar. (auth)

Theoretical Physics

Refer also to abstracts 17387, 17605, 17606, 17881, and 17898.

17829 (JINR-P1-3612) PLANIROVANIE FIZICHESKIKH EKSPERIMENTOV (OBZOR). (Design of Physical Experiments (Review)). Pazman, A.; Fedorov, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1967. 61p. (In Russian). Dep.

The existing statistical methods of designing experiments are described in a universally accessible form. (auth)

17830 PARTIAL GROUP-THEORETICAL TREATMENT FOR THE RELATIVISTIC HYDROGEN ATOM. **Bacry, H. (Inst. for Advanced Study, Princeton, N. J.); Richard J. L. J. Math. Phys. (N.Y.), 8: 2230-3(Nov. 1967).**

The Lie algebra of SU(1,1) and its Hermitian representations are used together with spherical harmonics to solve the wave equations for the nonrelativistic q-dimensional oscillator and the relativistic Kepler problem. (auth)

17831 INVARIANT TRANSFORMATIONS AND NEWMAN–PENROSE CONSTANTS. **Goldberg, Joshua N. (Syracuse Univ., N. Y.). J. Math. Phys. (N.Y.), 8: 2161-6(Nov. 1967).**

The relationship between constants of the motion and invariant transformations is discussed. Particular emphasis is placed on strong conservation laws which are of the form $U^{\mu\nu}_{\mu\nu} \equiv 0$. The existence of such a law leads to constants of the motion which are surface integrals and therefore generally do not generate an invariant transformation. However, when there is an associated weak conservation law, such that $t^{\mu}_{\mu} \equiv -\bar{\delta}y_A L^A$($L^A = 0$ are the field equations and $\bar{\delta}y_A$ the invariant change in field variables), a nontrivial invariant transformation exists. These results are applied to the discussion of the Newman–Penrose constants for the electromagnetic field. The conclusion arrived at is $\bar{\delta}y_A = 0$, which suggests that the invariant transformation generated by the Newman–Penrose constants is trivial. (auth)

17832 GREEN FUNCTION OF FREE PARTICLES. **Adawi, I. (Battelle Memorial Inst., Columbus, Ohio. Ohio State Univ., Columbus). Phys. Lett., 26A: 317-18(Feb. 26, 1968).**

The Green function $\langle R|(E-H_0+i\epsilon)^{-1}|R'\rangle$ for N free particles is evaluated by several methods. (auth)

17833 SUM RULES IN QUANTUM MECHANICS. **Ferreira, E. M.; Sesma, J. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (1), Suppl., 5: 1025-40(1967).**

It is shown how a wide family of related sum rules can be written by direct application of the closure relation for the eigenstates of Hermitian operators. The sum rules are generalized for the oscillator strengths, which include the use of operators more general than a Schroedinger Hamiltonian to form the set of base states, and the freedom to sum matrix elements of arbitrary operators. Application is made to the integrated cross section for the photonuclear effect. (L.B.S.)

17834 GENERAL CORRECTIVE PROCEDURE FOR THE NUMERICAL SOLUTION OF INITIAL-VALUE PROBLEMS. Hirt, C. W.; Harlow, Francis H. (Los Alamos Scientific Lab., N. Mex.). J. Comput. Phys., 2: 114-19(Nov. 1967). (LA-DC-8818).

In many circumstances the finite difference equations used in the solution of an initial-value problem must be solved by an iteration process at each time step. This paper proposes a technique that permits crude iteration to be used without leading to a disastrous accumulation of error after many cycles of time advancement. The technique, which is quite general, is discussed for two examples. The second of these applications accounts for the success of the Marker-and-Cell computing method for the solution of incompressible fluid flow problems. (auth)

17835 DIFFERENCE METHODS FOR THE INVISCID AND VISCOUS EQUATIONS OF A COMPRESSIBLE GAS. **Rubin, Ephraim L. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.); Burstein, Samuel Z. Contracts Nonr 839(34); AT(30-1)-1480. J. Comput. Phys., 2: 178-96(Nov. 1967).**

In this paper are examined several second-order accurate schemes for the solution of one-dimensional flows containing discontinuities. Two problems of shock interactions are considered, and two generalizations of these schemes are used for the solution of the Navier–Stokes equations. (auth)

17836 DIFFERENCE EQUATIONS FOR THE LEGENDRE POLYNOMIAL REPRESENTATION OF THE TRANSPORT EQUATION. **DeBar, Roger B. (Univ. of California, Livermore). J. Comput. Phys., 2: 197-205(Nov. 1967).**

The Legendre polynomial ("spherical harmonic") representation of the transport equation in plane and spherical symmetry is written in conservation form. Difference methods for the resultant equations are constructed and discussed. (auth)

17837 DETACHED SHOCK CALCULATION BY SECOND-ORDER FINITE DIFFERENCES. **Lapidus, Arnold (New York Univ., N. Y.). Contract AT(30-1)-1480. J. Comput. Phys., 2: 154-77(Nov. 1967).**

A detached shock problem for a symmetric curved convex cylindrical body moving parallel to its plane of symmetry was solved by using a third-order accurate Richtmyer form of the Lax–Wendroff conservation equations. One innovation is an easy to use "artificial viscosity" term which preserves the high order of accuracy of the calculation while removing the nonlinear instabilities which otherwise appear in the shock region and near boundaries. Another innovation is a simple transformation of Cartesian space which changes the curved body into a straight line, thus reducing the large number of special points and irregularly shaped mesh regions which would otherwise appear in the difference method calculation. Such transformations are shown to preserve the conservation property of the system of differential equations. Other aspects of the third-order artificial viscosity term and the transformation are discussed. The results of a numerical calculation on a CDC 6600 computer are compared with known results. (auth)

17838 NUMERICAL TECHNIQUES IN MATRIX MECHANICS. **Schwartz, Charles (Univ. of California, Berkeley). J. Comput. Phys., 2: 90-113(Nov. 1967).**

Several approximation techniques are presented for solving some model problems in quantum mechanics. The emphasis is on matrix representations rather than differential or integral equations. Some of the methods are already known (extension of the variational principle) and others are believed to be novel. (auth)

17839 THE QUESTION OF A "BEST" LOWER BOUND IN VARIATIONAL CALCULATIONS. Schmid, E. W.; Schwager, J. (Univ., Tuebingen, Ger.). Z. Phys., 210: 309-11(1968).

Information on the spectral representation of a trial wave function is used to improve the lower bound to the smallest eigenvalue of a quantum mechanical system, given by the formula of Temple. (auth)

17840 THE QUANTUM FLUCTUATIONS OF THE OPTICAL PARAMETRIC OSCILLATOR. II. **Graham, R. (Univ., Stuttgart). Z. Phys., 210: 319-36(1968).**

An effective Hamiltonian is set up for an optical parametric oscillator. It contains the Bose operators of the three modes, signal, idler, and pump and their coupling to heat baths. This Hamiltonian is shown to be equivalent to a set of equations of motion, derived in a previous paper (I) from a microscopically exact Hamiltonian, provided that the heat baths are chosen in an adequate way. The comparison with the laser Hamiltonian makes clear the close analogy of the underlying elementary processes of spontaneous emission from atoms and spontaneous parametric emission from light modes in nonlinear media. The Hamiltonian is used to derive a master equation for the statistical operator of the three-mode system. In the coherent state representation this master equation transforms into an equivalent c-number Fokker–Planck equation without any approximation. The solution is obtained below threshold by linearization and above threshold by quasilinearization of the nonlinear dissipation coefficients. The results agree with those which were obtained by quantum mechanical Langevin methods in a previous paper (I). (auth)

17841 PERTURBATION THEORY FOR RETARDED-TEMPERATURE GREEN'S FUNCTIONS. A SYSTEM OF FERMI PARTICLES WITH DIRECT INTERACTION. **Kovalchuk, V. G. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 1951-60(Dec. 1967). (In Russian).**

By means of iterations of equations for a Greenian (an operator, the statistical mean of which is a retarded Green's function) in a spectral representation, the perturbation theory series are obtained by the interaction potential for retarded Green's functions, analytical extension of which into a complex plane coincides with the perturbation theory series for Green's functions of Matsubara. It is shown that there exists a diagram technique for retarded Green's functions. (auth)

17842 THE QUANTUM FLUCTUATIONS OF THE OPTICAL PARAMETRIC OSCILLATOR. I. **Graham, R.; Haken, H. (Univ., Stuttgart).** Z. Phys., 210: 276-302(1968).

Treatment is based on a microscopically correct Hamiltonian which contains the Bose operators of the light modes and the Fermi operators of the optically active electrons in the medium. The coupling between modes and atoms is taken from quantum electrodynamics. Besides that, the light modes may interact with external "heat baths" like the mirrors, scattering centers, etc., while the atoms interact with lattice vibrations, incoherent light fields, etc. Using recently developed methods, the effect of these heat baths is taken into account in a quantum mechanically consistent fashion. Quantum mechanical Langevin equations are applied for the field and electron operators which contain dissipation and fluctuation terms. The elimination of the electron operators by an iteration procedure finally leaves a set of coupled nonlinear field equations which are shown to be quantum mechanically consistent. They are solved in the Heisenberg picture below threshold by linearization and well above threshold by quantum mechanical quasi linearization. The solutions show that the line width of the signal mode below threshold is due to the vacuum fluctuations in the idler and vice versa, whereas the thermal noise of the resonator and the spontaneous emission noise of the medium may be neglected. Above threshold the linewidth is caused by the undamped diffusion of the phase difference between signal and idler, to which the vacuum fluctuations of both modes contribute in equal parts. The phase sum of both modes adiabatically follows the slow phase diffusion of the external pump light produced by a laser, and therefore contributes to the linewidth too. Well above threshold the amplitudes are stable. Correlation and cross-correlation functions of their small residual fluctuations are calculated. (auth)

17843 FUNDAMENTALS OF QUANTUM OPTICS. **Klauder, John R.; Sudarshan, E. C. G. The Mathematical Physics Monograph Series. New York, W. A. Benjamin, Inc., 1968. 289p.**

This monograph is addressed to graduate students and physicists interested in intensity interferometry, photon counting correlations, and the laser. It contains an account of the fundamentals of quantum optics, including the quantum theory of partial coherence and the nature of the relation between classical and quantum theories of coherence. In the earlier chapters, the authors give a new presentation of the background material; much of the work in the later chapters is original. Especially complete treatments of properties of the coherent states and of the "diagonal" representation for statistical states are included, and application of these methods is made to studies of coherence, coincident counting rates and counting distributions for a number of physically significant states, including thermal and laser-like fields. The formal, "classical-like" viewpoint afforded by the "diagonal" representation is exploited throughout. (TSS)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

Refer also to abstract 16900.

17844 (DESY–F-32/3) ELEKTROERZEUGUNG VON π-MESONEN. (Electroproduction of π Mesons). Schmidt, Diethard (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jan. 1968. 68p. (In German).

In a spark chamber experiment, electroproduction of pions was studied by detecting coincidences between the scattered electron and one of the pions. The covered range of the energy q_0 of the virtual photon was $0.7 < q_0 < 3$ GeV, the range of the square of the four-momentum transfer q^2 was $0 \lesssim |q^2| \lesssim 0.1\ (\mathrm{GeV}/c)^2$. The measured rest-mass distribution of the unobserved system shows that at higher energies of the virtual photons multiple pion production dominates. A fit shows that these events are mainly due to electroproduction of ρ^0-mesons. In single-pion electroproduction, the dependence was measured of the square of the four-momentum transfer q^2, and of the azimuth angle between the plane defined by the virtual photon and the pion and the plane defined by the incoming and outgoing electrons. The differential cross section $d\sigma/dt$ for electroproduction of single positive pions is shown as a function of the four-momentum transfer to the recoil nucleon in the range $0.01 \lesssim |t| \lesssim 0.07\ (\mathrm{GeV}/c)^2$, integrated over the accepted range of q^2 and averaged over 3 intervals of q_0. In the limit $q^2 \rightarrow 0$ the given electroproduction cross section compares well with the known photoproduction cross section. The results are discussed on the basis of models of the photoproduction of single pions. (auth)

17845 RECENT EXPERIMENTAL DEVELOPMENTS IN ELECTROMAGNETIC INTERACTIONS. Hand, L. (Cornell Univ., Ithaca, N. Y.). pp 21-56 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

The current status of the low energy tests of quantum electrodynamics is briefly discussed. The interactions of high energy photons is next considered, and some results are presented of experiments with time-like photons and photoproduction of vector mesons. The situation on the leptonic decays of vector mesons is also summarized. A brief discussion is given on electron scattering. Finally, the photoproduction of π^0, π^+, and η is treated. (L.B.S.)

17846 DALITZ PLOT ANALYSIS FOR THE DECAY $\eta \rightarrow \pi^+\pi^-\gamma$. Cnops, A. M. (CERN, Geneva); Finocchiaro, G.; Mittner, P.; Zanella, P.; Dufey, J. P.; Gobbi, B.; Pouchon, M. A.; Mueller, A. Phys. Lett., 26B: 398-400(Feb. 19, 1968).

A purified sample of 1088 $\eta \rightarrow \pi^+\pi^-\gamma$ decays is corrected for detection efficiency effects. The $|\cos\theta|$ distribution indicates that the two pions are mainly in a J = 1 state. The γ energy dependence of the matrix element is incompatible with the simplest gauge invariant form but is well fitted by a ρ-dominance type model. (auth)

17847 SINGLE PHOTOPRODUCTION OF NEUTRAL π-MESONS ON HYDROGEN AT SMALL ANGLES BETWEEN 4 AND 5.8 GeV. Braunschweig, M.; Braunschweig, W.; Husmann, D.; Luebelsmeyer, K.; Schmitz, D. (Univ., Bonn. Kernforschungsanlage, Juelich, Ger.). Phys. Lett., 26B: 405-9(Feb. 19, 1968).

The differential cross section of the reaction $\gamma + p \rightarrow p + \pi^0$ was measured at mean photon energies of 4.0, 5.0 and 5.8 GeV and pion cms angles between 0 and 60°. The results are compared with theoretical calculations based on Reggeized vector meson exchange. (auth)

Weak

Refer also to abstract 17197.

17848 RECENT EXPERIMENTAL DEVELOPMENTS IN WEAK INTERACTIONS. Cronin, J. W. (Princeton Univ., N. J.). pp 3-20 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

Summaries are presented on new experimental results on weak interactions. It is noted that enormous progress has been made in some fields, notably CP violation in $K^0 \rightarrow 2\pi$ decay, while in others such as classical β decay, μ decay, μ capture and neutrino interactions there has been little progress. Tables are presentedon the form factor dependence in K_{e3} experiments, $K \rightarrow 3\pi$ decay rates, and recent searches for C, CP, or T violation outside the K^0 system, in addition to graphical representations of new data. (L.B.S.)

17849 SEARCH FOR DOUBLE BETA DECAY OF K^- MESON. Chang, C. Y. (Univ. of Maryland, College Park); Yodh, G. B.; Ehrlich, R.; Plano, R.; Zinchenko, A. Contract AT(40-1)-2504. Phys. Rev. Lett., 20: 510-13(Mar. 4, 1968). (ORO–2504-118).

An upper limit is reported for the branching ratio $R \equiv \Gamma(K^- \rightarrow \pi^+e^-e^-)/\Gamma(K \rightarrow \text{all})$ on the basis of a systematic analysis of 65,000 decaying K^- mesons in a 30-in. hydrogen bubble chamber. No examples of $K^- \rightarrow \pi^+e^-e^-$ were found; it is estimated that $R < 1.5 \times 10^{-5}$ (with 65% confidence). This result was obtained using the number of tau decays observed (3600) and the tau-decay branching ratio. (L.B.S.)

17850 MUON-PAIR PRODUCTION BY COSMIC-RAY MUONS. Morris, M. L.; Stenerson, R. O. (Univ. of Utah, Salt Lake City). Nuovo Cim. (10), 53B: 494-506(Feb. 11, 1968).

Thirty-three examples of muon pair production by muons were observed in a large cosmic-ray detector comprised of cylindrical spark counters and water Čerenkov counters having an automatic digitized data-handling system. These events were found in the analysis of 2,060,000 incident cosmic-ray muon trajectories recorded for study during 837 hours of running time between March and August 1966. Backgrounds from all sources contribute, at most, three events to this sample. The measured cross section agrees qualitatively with the theory of Murota et al. Experimental uncertainties prevent a more accurate comparison of theory and experiment. (auth)

17851 EXPERIMENTAL TEST OF THE LAW OF BARYON CONSERVATION. Gurr, Henry S. Cleveland, Case Inst. of Tech., 1966. 89p.

Thesis.

A 162 m^2 steradian scintillation detector located 3200 m below surface was used to look for high energy fragments from baryon non-conserving nucleon decay. A lower limit on the lifetime of the nucleon from 2×10^{28} to 8×10^{29} years, depending on the assumed decay mode, is established. (Disser. Abstr.)

Strong (Baryon-Induced)

Refer also to abstracts 17931 and 18112.

17852 (JINR–P1-3641) ITOGOVYE DANNYE PO UPRUGOMU p-p I p-d RASSEYANIYU NA MALYE UGLY I VESHCHESTVENNAYA CHAST AMPLITUDY p-n RASSEYANIYA V INTERVALE ENERGII 1-10 GeV. (The Data on the Elastic p-p and p-d Scattering at Small Angles and the Real Part of the p-n Scattering Amplitude in the Energy Range 1 to 10 GeV). Dalkhazhav, N.; Devinski, P.; Zayachki, V.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 14p. (In Russian). Dep.

The tables of differential cross sections of the elastic p–p and p–d scattering in the energy range 1–10 GeV and the specified data on the value of the real part of the p–n scattering amplitude in the energy range 1–10 GeV after the increase of statistics are given. The value of the real part is calculated on the basis of Glauber deuteron model. The experimental results are compared with the predictions, resulting from the dispersion relations for the scattering amplitude at t = 0, following from the general principles of the quantum field theory. The real part of the p–n scattering amplitude, obtained in the experiment, is compared with the data on n–p charge-exchange. (auth)

17853 PRESENT EXPERIMENTAL STATUS AND FUTURE PROSPECTS OF HYPERNUCLEAR PHYSICS. Davis, D. H. (University Coll., London); Sacton, J. pp 21-35 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

Recent results from the study of hypernuclei are summarized, and an attempt is made to outline the future prospects of this study. Binding energy determinations, meson (π^+) decay of light hypernuclei, $\Lambda\Lambda$ hypernuclei, and the study of nuclear properties from hypernuclei decay are covered. (J.F.P.)

17854 LOW-ENERGY HYPERON–NUCLEON INTERACTIONS. Alexander, G.; Karshon, U. (Weizmann Inst. of Science, Rehovoth, Israel). pp 36-59 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

The results of $\Lambda + p$, $\Sigma^+ + p$, and $\Sigma^- + p$ interactions are reviewed. Also information obtained on the hyperon–nucleon system from final-state interactions is briefly discussed, and future experiments are mentioned. (J.F.P.)

17855 ELASTIC INTERACTIONS (np) AT 3 TO 30 GeV. Besliu, Calin; Besliu, Tatiana; Constantinescu, Anisoara; (and others) (Univ., Bucharest. Institut Unifie de Recherches Nucleaires, Dubna, USSR). Compt. Rend., Ser. A and B, 265: 1350-3 (Dec. 6, 1967). (In French).

The results obtained on the elastic interaction of neutrons with protons in a propane bubble chamber are reported. The differential and total elastic cross sections were studied for two energy regions from 3 to 6 and from 6 to 10 BeV in the momentum transfer region of 0.06 to 0.3 $(\mathrm{BeV}/c)^2$. The values obtained for the two energy regions are tabulated and compared with the data of Kreisler. The agreement is good. In the region from 6 to 10 BeV no data are available for neutron–proton interactions, but the variation of the slope b with the energy seems to verify the consequences indicated by the Regge theory. (J.S.R.)

17856 RECENT EXPERIMENTAL DEVELOPMENTS IN STRONG INTERACTIONS. Goldhaber, G. (Univ. of California, Berkeley). pp 57-107 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967. See CONF-670824.

Some selected topics which represent new work in the field of strong interactions are discussed. These include elastic scattering cross sections; new determination of low-energy scattering length and coupling constants; branching ratios for η decay; and the axial vector K^* mesons. (L.B.S.)

17857 EXPERIMENTAL DATA ON HADRON INTERACTIONS IN GeV REGION. Yukawa, H. (ed.). Progr. Theor. Phys. (Kyoto), Suppl. No. 41-42, 1-422(1967).

Seven papers are presented. Part I includes six papers which review experimental data published from 1960 to October 1966. Brief reviews on several phenomenological models are given in Part II. A separate abstract was prepared for each paper. (L.B.S.)

For abstracts of individual papers see: 17858–17860, 17871–17873, and 17931.

17858 NUCLEON- AND ANTINUCLEON-NUCLEON ELASTIC AND CHARGE EXCHANGE PROCESSES. Sumi, Yoshio; Yoshida, Toshihiro (Osaka Univ. Kyoto Univ.). Progr. Theor. Phys. (Kyoto), Suppl. No. 41-42, 53-89(1967).

Experimental data on nucleon-nucleon and nucleon-antinucleon elastic interactions in the high energy region are summarized and presented. The data include total and total elastic cross sections; singular distribution of elastic and charge-exchange cross section; and recoil proton polarization, together with the ratio of the real to imaginary forward amplitude in the pp elastic scattering. In the appendix several kinematical quantities are tabulated. Values of the incident laboratory momentum, observed quantities, and the method used are presented for the 67 references, which cover a main part of the experimental information published from 1960 to 1966. (L.B.S.)

17859 NN INELASTIC PROCESSES. Fujimura, Kimio (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto), Suppl. No. 41-42, 282-315(1967).

Experimental data obtained from accelerators are summarized for pp inelastic scattering, and their characteristic features are shown. The data are separately compiled for the two final channels; the quasi-elastic scattering (isobar production) and the multiple production. Some cosmic ray data are also included. Twenty-five references are tabulated together with incident momentum, observed quantities and experimental methods. (L.B.S.)

17860 ANTINUCLEON–NUCLEON INELASTIC PROCESSES. Iwaki, Atsuko (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto), Suppl. No. 41-42, 316-373(1967).

Experimental data on antinucleon-nucleon inelastic interactions published from 1963 to 1966 are summarized. Cross sections are first given of typical $\bar{p}p$ processes at various energies. Experimental results are then summarized for the four types of reactions: annihilation into pions; annihilation yielding K mesons; pion production without annihilation; and hyperon production. Annihilation data include cross sections for various annihilation channels, production angular distributions and mean multiplicity for produced particles, the rates of resonance productions, and distribution of the production and decay angles for resonance particles. Pion production without annihilation and hyperon production data include cross sections, angular distribution of final antibaryons (baryons), and resonance production. Thirty-seven references are arranged according to the reaction types, and include the primary momentum, observed quantities, and method used. Seventeen other references are given. (L.B.S.)

17861 NEUTRON–PROTON AND NEUTRON–DEUTERON TOTAL CROSS SECTIONS FROM 14 TO 27 GeV/c. Kriesler, Michael N. (Princeton Univ., N. J.); Jones, Lawrence W.; Longo, Michael J.; O'Fallon, John R. Phys. Rev. Lett., 20: 468-71 (Feb. 26, 1968).

The first direct measurements of neutron-proton and neutron-deuteron total cross sections in the momentum range 14 to 27 GeV/c are presented. The np total cross section apparently becomes less than the pp total cross section in this momentum region. Our results show no evidence for a rapid vanishing of the Glauber screening correction as predicted by Abers et al., on the basis of Regge theory. (auth)

17862 SEARCH FOR LONG-LIVED HEAVY PARTICLES IN COSMIC-RAY EVENTS AT ENERGIES ABOVE SEVERAL THOUSAND GeV. Bjornboe, J. (Univ. of Copenhagen); Damgard, G.; Hansen, K.; Chatterjee, B. K.; Grieder, P.; Klovning, A.; Lillethun, E.; Peters, B. Nuovo Cim. (10), 53B: 241-63(Feb. 11, 1968).

Two experiments are described, designed to search for heavy, long-lived particles (mass $\gtrsim 5\ \mathrm{GeV}/c^2$, lifetime $\gtrsim 10^{-6}$ s) with strong and/or electromagnetic interactions. If such particles exist, they may be expected to occur in air showers and some should arrive at sea level, delayed with respect to the bulk of air shower particles, yet carrying a large amount of energy. The apparatus was constructed so as to register particles delayed from 20 to 520 ns with respect to an air shower and capable of penetrating a large amount of matter (ranging from 1600 to 3600 g/cm^2). In the first experiment the particles had to be at least singly charged or to interact in 1.6 tons of detector. In the second experiment it was required that the particles had a reasonably large cross section for pion production. The result of the experiments is negative; upper limits for the occurrence of signals due to delayed energetic particles lie between 10^{-10} and $3(10^{-10})\ \mathrm{cm}^{-2}\ \mathrm{s}^{-1}$. Upper limits on the production cross section of such particles can be obtained only by assuming a particular model for their production and propagation. One can infer however that, if particles of this kind exist, their production cross section must be small even in the energy range from 10,000 to 50,000 GeV. A particular model, which is discussed yields upper limits in the region of 10 μb for the production of particles which are about ten times as heavy as nucleons. (auth)

17863 PRODUCTION OF THREE CHARGED PIONS IN $\bar{p} + n$ ANNIHILATION AT REST. Anninos, P. (Syracuse Univ., N. Y.); Gray, L.; Hagerty, P.; (and others). Phys. Rev. Lett., 20: 402-6(Feb. 19, 1968).

A sample of 2785 events of the reaction $\bar{p} + n \rightarrow 2\pi^- + \pi^+$ was measured, which are due to antiproton capture at rest in deuterium. An analysis of the ($I^GJ^P = 1^-0^-$) three-pion final state was attempted in terms of the π-π interaction. (auth)

Strong (Meson-Induced)

Refer also to abstracts 17856, 17857, and 17931.

17864 (CEA-R-3401) SITUATION EXPERIMENTALE DE LA DIFFUSION ELASTIQUE π-NUCLEON EN DESSOUS DE 2 GeV. (Experimental Situation of π-Nucleon Elastic Scattering Up to 2 GeV). Bareyre, Pierre; Bricman, Claude; Villet, Gerard (Commissariat a l'Energie Atomique, Saclay (France). Center d'Etudes Nucleaires). Dec. 1967. 65p. (In French). Dep.

Experimental data on the π-nucleon elastic scattering have been collected up to 1967 for use in a phase shift analysis. They refer to total cross sections, angular distributions and recoil proton polarizations, for energies less than 1.8 GeV. (auth)

17865 (INR-P–844/VI/PH) SOME FEATURES OF NEUTRAL PION PRODUCTION IN INTERACTIONS OF 9 GeV NEGATIVE PIONS WITH XENON NUCLEI. Siemiarczuk, T. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 14p. Dep.

The energy and angle of emission of 3271 photons emitted in 1374 Π^--Xe interactions at 9 GeV were measured and the process leading to Π^0 production is discussed. (auth)

17866 (JINR–P1-3677) ISSLEDOVANIE REAKTSII $\pi^- + p \rightarrow \pi^- + \pi^+ + n + \pi^0 + \pi^0$ PRI IMPUL'SE π^- MEZONOV 4 GeV/c. (Investigation of the Reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n + \pi^0 + \pi^0$ at 4 GeV/c π^--Mesons). Grishin, V. G.; Gulyamov, K. G.; Kopylova, D. K.; Muminov, M. M.; Trka, Z.; Yuldashev, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 23p. (In Russian). Dep.

The reaction $\pi^- + p \rightarrow n + \pi^+ + \pi^- + \pi^0 + \pi^0$ at pC = 4 GeV was investigated using a 24-liter propane bubble chamber. Average weights of the events with γ-quanta were introduced. A narrow peak was obtained in the effective mass $M(\gamma\gamma)$ in the region of π^0-mesons with a half-width equal to ±7%. The reaction cross section turned out to be $\sigma(2\pi^0) = (3.4 \pm 0.6)$ mb. The spectra of effective and missing masses were studied. The data are obtained indicating a possible production of the isobar $N^* \rightarrow n + \pi^0 + \pi^0$ with $M(N^*) \geq 2$ GeV. (auth)

17867 (RPP/H-33) OBSERVATION OF AN ENHANCEMENT IN THE $I = 0$ $\pi^+\pi^-$ SYSTEM AT 1085 MeV. Whitehead, C. (Atomic Energy Research Establishment, Harwell (England)); McEwen, J. G.; Ott, R. J. (Southampton Univ., (England). Dept of Physics); Aitken, D. K.; Bennett, G.; Jennings, R. E. (University Coll., London (England). Dept. of Physics). [1967]. 13p. Dep. CFSTI. UK.

Some results of an investigation of the $\pi^+\pi^-$ system produced in the reaction $\pi^-p \rightarrow \pi^+\pi^-n$ using 3.1 to 3.6 GeV/c pions from NIMROD are described. A report was submitted to the conference on High Energy Physics held at Heidelberg earlier in the year, and a complete analysis of the full experimental work will be published later. The studies described emanate from AERE, Harwell, and the Universities of London and Southampton. (auth)

17868 SIGMA HYPERON PRODUCTION IN 2- AND 3-BODY FINAL STATES. Cooper, W. A.; Manner, W.; Musgrave, B.; Voyvodic, L. (Argonne National Lab., Ill.). Phys. Rev. Lett., 20: 472-5(Feb. 26, 1968).

The final states Σ^+K^+ and Σ^+K^{*+} are found to be produced peripherally with evidence, in both cases, for a small backward peak. The forward differential cross sections for both reactions are compared with the predictions of a Regge-pole model. For Σ^+K^{*+} it is found that the angular correlations in the resonance decay are predicted quite well by an absorptive peripheral model although the model is unable to account for the production angular distribution. (auth)

17869 PION–NUCLEON CHARGE-EXCHANGE SCATTERING AND HIGH-ENERGY DYNAMICS. II. POLARIZATION EFFECTS. Van Hove, Leon. Comments Nucl. Particle Phys., 2: 10-14 (Jan.-Feb. 1968).

It is pointed out that Regge-model predictions for the laboratory momentum dependence of the amplitude for $\pi^- + p \rightarrow \pi^0 + n$ interactions is contradicted by polarization measurements of a Orsay–Pisa–Saclay group at CERN. Various possibilities for a modified momentum dependence are illustrated. (L.B.S.)

17870 AN ESTIMATE OF THE CROSS SECTION FOR Λ AND Σ^0 PARTICLE PRODUCTION IN LEAD BY LONG-LIVED K^0 MESONS WITH A MEAN ENERGY E = 150 MeV. Mestvirishvili, A. N.; Nyagu, D.; Petrov, N. I.; Rusakov, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 54: 49-51(Jan. 1968). (In Russian).

The cross section for production of Λ and Σ^0 particles in lead by K_L^0 mesons with a mean energy E = 150 MeV is measured. The cross section is found to be $\sigma = (212 \pm 38) \cdot 10^{-27}$ cm^2. (auth)

17871 MESON-NUCLEON ELASTIC AND CHARGE EXCHANGE PROCESSES. Sumi, Yoshio (Osaka Univ.). Progr. Theor. Phys. (Kyoto), Suppl. No. 41-42, 3-52(1967).

An extensive survey of experimental data on elastic πN and KN interactions up to 30 GeV/c is systematically arranged and presented. The data include total and total elastic cross sections as a function of the incident laboratory momentum (p_L), elastic differential cross sections, polarization of recoil proton, and charge-exchange scattering. Values of p_L, observed quantities, and the experimental technique are presented for the 113 references, which represent the main part of the experimental information published from 1960 to 1966. (L.B.S.)

17872 ΠN INELASTIC PROCESSES. Ohba, Ichiro; Kobayashi, Tetsuro (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto), Suppl. No. 41-42, 90-218(1967).

Experimental data on πN inelastic processes published from 1964 to 1966 are compiled. Attention is given to data on the quasi-two-body processes which involve the meson resonance and/or the baryon resonance. Nonresonant direct process (>10 GeV/c) and strange particle production are treated separately from the quasi-two-body processes. The incident momentum, reaction, observed quantities, and method are given with each of the 122 references. (L.B.S.)

17873 K–N INELASTIC PROCESSES. Kanada, Hiroyuki; Matsuoka, Takeo; Suzuki, Tsuneo (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), Suppl. No. 41-42, 219-81(1967).

A review is given of experimental results on the inelastic K-N scattering at various primary momenta above 1.4 GeV/c. Reactions of the following two types are considered: quasi-two-body reactions in which there are more than two particles in the final state, and many-body reactions in which there are more than two particles in the intermediate and/or final state. The cross section for each inelastic channel in the K-N scattering and its momentum dependence are presented. Angular distributions of particles or resonances produced in the K-N inelastic processes and decay angular distributions of the produced resonances are shown. Polarizations of the Ξ^- particle in the $K^- p \rightarrow \Xi K$ reaction are given. The dominant characteristics of all angular distribution in the inelastic reactions and characteristics of all resonances produced in the K-N scattering are summarized. The 57 references are tabulated in the appendix together with the incident momentum, observed quantities, and experimental methods. (L.B.S.)

17874 THREE-PRONG INTERACTION OF π^--MESONS WITH A MOMENTUM OF 4 GeV/c IN A PROPANE BUBBLE CHAMBER. Jires, M.; Novak, M.; Petrzilka, V. Czech. J. Phys., 18: 240-7 (1968). (In Russian).

Altogether 1648 cases of three-prong interaction of mesons-(π^-) with a 4 GeV/c momentum were found on 90,000 pictures from a propane bubble chamber 55 × 28 × 14 cm^3 in size; all three secondary particles were pions, two having a negative and one a positive charge. Analysis of these cases showed that at a momentum of 4 GeV/c of primary π^--mesons the process of the coherent production of pions was not observed. On the other hand, this analysis led to an interesting result: (19 ± 9)% of the total number of (π^+,π^-) pairs in "A" interactions is due to the decay of the meson $\rho^0 \rightarrow \pi^+ + \pi^-$. A value of $M\rho_0 = (764 \pm 36)$ MeV was obtained for the mass $M\rho_0$ of ρ_0 mesons and $\Gamma_{\rho_0} = (166 \pm 55)$ MeV fort the width Γ_{ρ_0} of its resonance curve. Investigation of the distribution of masses $M_{3\pi}$ in the case in question gave no answer due to the insufficiently determined course of the background curve. (auth)

17875 LOW ENERGY K^--p ELASTIC INTERACTION. Thomas, G. P.; Jain, P. L. (State Univ. of New York, Buffalo). Phys. Lett., 26B: 401-4(Feb. 19, 1968).

Forty-four K^--p low momentum elastic scattering events between 0 and 250 MeV/c were found by following 265.12 meters of K^- meson tracks, backward from their capture points in nuclear emulsions. The total scattering cross section is plotted as a function of kaon momentum and this is fitted with the s-wave zero-effective-range theory with the scattering lengths $A_0 = -1.1 + 0.55\,i$, $A_1 = -0.20 + 0.44\,i$ for the isotopic spin T = 0 and T = 1 channel respectively. Further evidence for s-wave interaction is discussed through the angular distribution in the cms system for the elastic events. (auth)

17876 X^0 PRODUCTION IN π^-p INTERACTIONS. Dufey, J. P. (Eidgenoessische Technische Hochschule, Zurich): Gobbi, B.; Pouchon, M. A.; Cnops, A. M.; Finocchiaro, G.; Lassalle, J. C.; Mittner, P.; Muller, A. Phys. Lett., 26B: 410-12(Feb. 19, 1968).

A study of the reaction $\pi^-p \rightarrow X^0n$ near threshold for two incident pion momenta has yielded the following values of the cross section: (22 ± 4) μb at 1.50 GeV/c and (33 ± 6) μb at 1.52 GeV/c. These cross sections refer to the decay mode $X^0 \rightarrow \pi^+\pi^-\eta(\eta \rightarrow$ neutrals). (auth)

17877 DISCOVERING A SECOND CASE OF A BINARY HYPERNUCLEUS. Filimonov, V. A. Usp. Fiz. Nauk, 92: 535-8(July 1967). (In Russian).

A binary hypernucleus is a bound baryon system containing two Λ-hyperons. These systems are formed on capture of a Ξ^--hyperon by a nucleus. On falling into the nucleus the Ξ^--hyperon forms two Λ-particles as a result of the reaction $\Xi^- + p \rightarrow \Lambda + \Lambda + 28.5$ MeV. Since the energy liberated in this reaction is small, the Λ-particles are readily captured by a nuclear fragment to form a binary hypernucleus. On irradiating a nuclear emulsion stack with K^--mesons of 1.5 BeV/c a sequence of events was observed which admitted of no other interpretation other than the formation and subsequent cascade decay of a binary hypernucleus. Two successive π-meson decays gave favorable conditions for identifying and determining the binding energy of a binary hypernucleus. The excess binding energy of two Λ in a binary hypernucleus is estimated at 4.6 ± 0.5 MeV from two independent observations by Danysh and Prowse. (TTT)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 18027.

17878 ELEMENTARY PARTICLE RADIATION. Stanyukovich, K. P. Dokl. Akad. Nauk SSSR, 175: 1252-5(Aug. 21, 1967). (In Russian).

In quantum field theory, the noninteracting elementary particles are assumed to be localized in a point. As a result of interaction, the particles become blurred. In a gravitational field, such blurred particles, e.g., electrons or nucleons, possess dimensions which depend on the gravitational constants and Planck's constant. It is shown that the mean square fluctuation of the velocity of particles produced by the interaction with the gravitational field is $\overline{\nu^2} = 3\,kT_g/m$, where kTg is the energy of the quantum of the gravitational field and T_g is its temperature. From this, it was found that $\sqrt{\Delta\nu^2}/c = 10^{-20}$. An expression was derived to determine the dimensions of particles in a gravitational field on these bases. After having considered the fluctuations of the dimensions of the originally quasi-Euclidean space, the nonfluctuating Riemann space is examined, determining the necessary corrections. (TTT)

17879 THREE-BODY PROBLEM WITH LEE-TYPE INTERACTION. Hannover, H. (Max-Planck-Institut fuer Chemie, Mainz). Z. Phys., 210: 193-215(Feb. 12. 1968).

A solvable three-body problem is studied. It contains a Lee-type three-body interaction effected by virtual transitions $\Theta + N + N' \rightleftharpoons \Psi$ plus some two-body forces. The system may have several three-particle bound states as well as two-particle bound states and resonances, such that scattering and disintegration processes may be studied explicitly. (auth)

17880 ON AN ATTEMPT TO REDUCE THE NUMBER OF BASIC CONSTANTS IN ELEMENTARY PARTICLE PHYSICS BY INTRODUCING PSEUDOSCALAR PARAMETERS. PART III. THE MASS SPECTRUM OF FERMIONS (REVISED) AND MESONS. Eriksson, H. A. (Royal Inst. of Tech., Stockholm). Ark. Fys., 34: 239-45(1967).

In Part I (1962) of this series a complete set of four parameters, behaving like ordinary constants under proper Lorentz transformations but having different transformation properties under the three kinds of inversion P, T, and PT were chosen as coefficients of the derivative terms in a generalized Dirac equation and another complete set of four parameters as coefficients of the mass terms. The experimental values for the masses of seven selected fermions were used to calculate the ratios between the eight parameters. Then the masses of the remaining three fermions could be calculated, and were found to agree very well with the experimental values. Since 1962, however, these values have changed a little, and the agreement is no longer particularly good. In the present paper we have succeeded in finding another classification scheme, i.e., other combinations of parameters for various particles, which restore the agreement. Moreover, it turned out that this new scheme also gives the mass of the π, K, and η mesons, if it can be accepted that the wave equations for the π and K mesons are noninvariant under P inversion and the wave equation for the η meson noninvariant under P as well as T inversion. (auth) (Swed)

17881 MODEL OF A DYNAMICAL THEORY OF THE PAULI PRINCIPLE. Corinaldesi, E. (Boston Univ.). Nuovo Cim. (1), Suppl., 5: 937-43(1967).

The fact that nature seems to order systems of "identical" bosons and fermions in a special way is considered, and an attempt is made to show that this ordering may be conceived as a dynamical process of which only the final stage is normally observed. It is shown that the introduction of a nonlinear interaction into the Schroedinger equation for two or more bosons or fermions would allow one to describe separated particles by nonsymmetrized wave functions and to retain their identity, while the symmetrization of the wave function (and the ensuing loss of particle identity) would be the consequence of the dynamical evolution of the system. Two-particle and many-particle systems are considered. (C.E.S.)

17882 CURRENT DIVERGENCIES. Enkovski, L.; Kukhtin, V. V.; Montvai, I.; Nguyen Van Heu (Joint Inst. for Nuclear Research, Dubna, USSR). Dokl. Akad. Nauk SSSR, 176: 298-300 (Sept. 11, 1967). (In Russian).

It has been assumed that it is possible to verify simultaneously the commutation ratios of vector and axial currents. This problem was examined, assuming for simplicity's sake that the unitary symmetry is not disturbed by strong interactions, and that the divergence of axial currents is proportional to the pseudoscalar fields. The study showed that Gell-Mann's simultaneous commutation ratios and the Beltman theory concerning the divergence of currents are due to the same quark model. Beltman's results were further extended to cover cases in which nonleptonic weak interactions are taken into account. The generalized current divergence theory also clarifies all relations between the amplitudes of nonleptonic decays of baryons and mesons, as derived earlier from the current algebra. The calculation showed how Beltman's current divergence theory can be clarified by a quark model with minimal electromagnetic interactions and universal weak interactions. (TTT)

17883 CURRENT ALGEBRA AND SUM RULES. Low, Francis E. Comments Nucl. Particle Phys., 2: 15-17(Jan.-Feb. 1968).

The assumptions upon which successful applications of current algebra have been based are reviewed—the algebra of axial and vector charges and the PCAC hypothesis. Sum rules based on the assumptions of the unintegrated local version of the algebra and the convergence of unsubtracted dispersion relations are briefly discussed. It is pointed out that the Adler–Weisberger sum rule approximately verifies the axial charge-commutation relation, PCAC, and the no-subtraction hypothesis; the Cabibbo–Radicati sum rule approximately verifies the first moment of the vector commutation relation and the no-subtraction hypothesis. (L.B.S.)

17884 ELEMENTARY PARTICLES OF MATTER. Gell-Mann, Murray. pp 3-14 of Scientific Progress and Human Values. Hutchings, Edward; Hutchings, Elizabeth (eds.). New York, American Elsevier Publishing Co., Inc., 1967.

From Conference on Scientific Progress and Human Values, Pasadena, Calif. See CONF-661058.

A review of elementary particle theory is given. Included in the discussion are the four kinds of interactions, quantum theory, neutrinos, leptons, hadrons, the particle symmetries, antiparticles, multiplets and supermultiplets, mass and energy the bootstrap model and the quark model. (J.F.P.)

17885 NEW DETERMINATION OF κl IN NONLINEAR SPINOR THEORY. Schomblond, Chr.; Michel, Fr. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg., 53: 605-22(1967). (In French).

The expression of the integral equations are simplified by the use of graphic representations. The equation of the baryons furnished by the first two terms of the three-point φ development in Neumann formal series was constructed graphically. The algebraic properties and the theorems relative to the composition products are shown; this makes it possible to reduce the baryon equation to a form which contains only a single new function $G(\lambda)$. The integral representation of $G(\lambda)$ used for numerical calculation is given. The results of the different iterations are discussed as a function of the nonlinear term sign of the Heisenberg equation and of the physical significance attributed to the graphs. (tr-auth)

17886 PROCEEDINGS OF THE 1967 INTERNATIONAL CONFERENCE ON PARTICLES AND FIELDS, UNIVERSITY OF ROCHESTER, NEW YORK, AUGUST 28–SEPTEMBER 1, 1967. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967. 716p. (CONF-670824).

Forty papers were presented at the conference, whose aim was to provide a forum for an intensive examination of several key problems of particle physics by theorists representing all subdisciplines. Each section was focused on a major theoretical theme. The discussions which followed each presentation are also included. Four papers were previously abstracted for NSA; see: 21: 46530, 22: 1426, 7541, and 7565. A separate abstract was prepared for each of the remaining papers. (L.B.S.)

For abstracts of individual papers see: 17845, 17848, 17856, 17887–17889, 17892, 17894, 17895, 17912–17914, 17932–17937, 17942, 17953, 17980, 17981, 17997, 18000–18009, and 18033–18035.

17887 CURRENT DENSITY ALGEBRAS AND INFINITE MULTIPLETS. Ruhl, W. (CERN, Geneva). pp 402-12 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

A representation theory is outlined for the model proposed by Gell-Mann and Dashen for the study of charge density algebra in a single particle space. The representations have a close relation to unitary representations of noncompact groups. (L.B.S.)

17888 INTERRELATION BETWEEN SUM RULES AND DYNAMICS. Amati, D. (CERN, Geneva). pp 503-14 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

An attempt is made to illustrate in a simple way the relation between dynamical assumptions on the high energy behavior of scattering amplitudes and current algebra. It is also shown that current algebra provides a general framework into which all kinds of dynamics may be introduced and that different sum rules will be obtained depending on what dynamical assumptions are made. The motivation for right signature fixed poles is briefly discussed for photon or lepton production of lepton pairs, Compton scattering, and photon or lepton production of hadrons. (L.B.S.)

17889 THE USE OF THE KHURI REPRESENTATION IN CURRENT ALGEBRA AND SUPERCONVERGENCE. **Furlan, G.** (Trieste Univ., Italy). pp 515-21 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

The problem of translating the set of algebraic identities between invariant functions in current algebra into sum rules written as dispersive integrals is treated using the Khuri representation. (L.B.S.)

17890 HIGH ENERGY PHYSICS AND NUCLEAR STRUCTURE. Proceedings of the Second International Conference held at Rehovoth, February 27–March 3, 1967. **Alexander, Gideon (ed.).** New York, John Wiley and Sons, Inc., 1967. 496p. $23.00. (CONF-670207).

The conference included 49 papers three of which were previously abstracted in NSA. For abstracts of these papers see abstract numbers 21: 17211, 21: 23402, and 21: 27515. Separate abstracts were prepared for 20 papers. Other papers appeared in abstract form only. (J.F.P.)

For abstracts of individual papers see: 17196, 17197, 17199, 17853, 17854, 17891, 17926–17929, 17941, 17952, 17973, 17974, 18110, and 18310–18314.

17891 REMARKS ON NUCLEAR STRUCTURE AND HIGH-ENERGY PHYSICS. **De-Shalit, A.** (Weizmann Inst. of Science, Rehovoth, Israel). pp 1-5 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

The field of nuclear structure is reviewed and its possible interactions with high-energy physics are considered. The use of elemantary particles for the determination nuclear structure is stressed. (J.F.P.)

Electromagnetic

Refer also to abstracts 17913 and 17921.

17892 INFINITE MULTIPLETS AND CONTINUOUS MASS SPECTRA. **Fronsdal, C.** (International Center for Theoretical Physics, Trieste, Italy). pp 374-82 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

An attempt is made to construct a theory of infinite multiplets using an intermediate approach which treats the propagator empirically but accepts the vertex function of infinite component field theory. The Compton scattering amplitude is treated within this framework; the case of continuous mass spectra and exchange amplitudes is considered. (L.B.S.)

17893 ANGULAR DISTRIBUTION OF CHARGED PARTICLES DURING PAIR PRODUCTION BY PHOTONS AND THE EFFECT OF MULTIPLE SCATTERING. **Kudryavtsev, V. G.; Kalashnikov, N. P.; Ryazanov, M. I.** (Moscow Engineering-Physics Inst.). Zh. Eksp. Teor. Fiz., 54: 183-7(Jan. 1968). (In Russian).

The effect of multiple scattering on the angular and energy distribution of charged particles produced by photons in a condensed medium is considered. It is shown that multiple scattering lowers the rate of the process at small angles and leaves it unchanged in the large angle range. Integration of the formula over the angles leads to Migdal's result. (auth)

17894 PROGRESS IN CURRENT ALGEBRA. **Weisberger, W. I.** (Princeton Univ., N. J.). pp 429-46 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

Recent developments in current algebra are reviewed, which go beyond previous results to derive consequences that make more specific assumptions on the behavior of gradient terms, commutation rules of operators, and the high energy behavior of matrix elements. Examples are given of the results achieved, the assumptions needed to derive them, and the experimental tests. The following topics are discussed: $K \to 3\pi$ and $\eta \to 3\pi$ decays; algebra of current densities; radiative corrections to β decay; and spectral function sum rules. (L.B.S.)

17895 DIVERGENCE QUESTIONS IN RELATION TO PION MASS DIFFERENCE. **Bell, J. S.** (CERN, Geneva). pp 530-7 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

The question of divergence in the calculation of pion mass difference is considered within the framework of current algebra and field algebra. (L.B.S.)

17896 NEW FORM OF CHARACTERISTIC FUNCTIONAL FOR CASCADE PROCESSES. **Scott, W. T.** (Univ. of Nevada, Reno). J. Math. Phys. (N.Y.), 8: 2170-9(Nov. 1967).

The characteristic functional for an energy-dependent cascade process is redefined so as to introduce the arbitrary function without using exponentials. An immediate consequence is that the functional becomes the function at $t = 0$ when the process is multiplicative with one particle at the initial time. A simple one-component model of a cosmic-ray shower is used to illustrate how this definition leads directly to a simple form of the Chapman–Kolmogoroff equation, forward and backward integro-differential equations for the functional and the derivation of all probability functions of interest for the process. An example is given of the distributions in number of particles at different depths when the total cross section for multiplication is proportional to the energy. Some general forms of functional are proposed. The extension to electron-photon showers is outlined. (auth)

17897 PHOTOPRODUCTION OF BOSONS. **Ferroni, S.** (Ecole Normale Superieure, Orsay, France); **Gracco, V. G.; Schaerf, C.** Nuovo Cim. (1), Suppl., 5: 1051-78(1967).

An attempt is made to present the most relevant experimental facts about multiple-pion photoproduction together with the various theoretical models which have been developed. (L.B.S.)

17898 INSTANTANEOUS VELOCITY OF THE ELECTRON FIELD. **Perkins, G. A.** Nuovo Cim. (1), Suppl., 5: 786-93 (1967).

The instantaneous velocity of the electron field was obtained from a mathematical study of the Dirac spinors using Kramer's vector–spinor relation. (L.B.S.)

17899 PHOTOPRODUCTION OF POSITIVELY CHARGED PIONS AT HIGH ENERGIES. **Dietz, K; Korth, W.** (Univ., Bonn. Kernforschungsanlage, Juelich, Ger.). Phys. Lett., 26B: 394-7(Feb. 19, 1968).

It is found that a Regge-pole model of an evasive π trajectory interfering with even-signature, $-G = I = 1$ opposite spin-parity conspirator trajectories seems to fit data on high-energy π^+ photoproduction quite well. The interaction $\gamma + p \to n + \pi^+$ at high energies is considered. (J.F.P.)

17900 ELECTROMAGNETIC STRUCTURE OF NUCLEONS. **de Vries, C.** (Instituut voor Kernphysisch Onderzoek, Amsterdam). Ned. Tijdschr. Natuurk., 33: 323-54(Oct.-Nov. 1967). (In Dutch).

A theoretical introduction is given of the formulas used in the analysis of electron scattering studies. A description is given of the experimental methods for the production of electron beams. Measurements for the justification of the assumption that a photon was annihilated in the interaction between electron and nucleon were described. Experimental methods possible with electron beams are described. Form factor material is presented and interpreted. (tr-auth)

17901 A CONTRIBUTION OF C-NONINVARIANT γ INTERACTION TO THE LEPTON PAIR PRODUCTION. **Kawamiya, Osamu** (Kobe Univ., Japan). Progr. Theor. Phys. (Kyoto), 38: 1401-2(Dec. 1967).

Corrections to the cross section for wide-angle pair production due to processes which are different from ordinary Q.E.D. processes and may be appreciable at higher energy and larger momentum transfer are proposed. A vector meson case is considered primarily. (J.F.P.)

17902 VECTOR MESON EXCHANGE MODEL FOR THE ELECTROMAGNETIC MASS DIFFERENCE OF PSEUDOSCALAR MESONS. **Sakuma, Tetsuro** (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto), 38: 1404-6(Dec. 1967).

A simple field-theoretical model which illustrates how the dynamical self-consistency requirement operates for the $\pi^+ - \pi^0$ and $K^+ - K^0$ mass differences is proposed assuming that the vector and pseudoscalar intermediate states are dominant. The values of self-energy integrals with vector meson exchange versus cutoff energy are shown. It is concluded that the simple vector meson exchange model gives approximately the correct sign for the studied electromagnetic mass differences. (J.F.P.)

17903 POLARIZATION IN HIGH-ENERGY ELECTRON-PROTON SCATTERING. Kolsrud, M.; Waldenstroem, S. (Univ. of Oslo). Phys. Norv., 2: 211-30(1967).

A complete treatment is given of all polarization quantities and cross sections for scattering of two different fermions, in particular for transitions to arbitrary final polarization states. The case of high-energy electron-proton scattering is considered in detail, and previous results are extended. Various relations between the polarization quantities are obtained. All formulae contain the electric and the magnetic form factor of the proton. Two-component formalism for each particle is used. (auth)

17904 REGGE-POLE MODEL FOR PHOTOPRODUCTION OF PIONS AND K MESONS. Ball, James S. (Univ. of California, Los Angeles); Frazer, William R.; Jacob, M. Phys. Rev. Lett., 20: 518-22(Mar. 4, 1968).

High-energy data on photoproduction of pions and K mesons are fitted with a Regge-pole model involving conspiring trajectories. (auth)

17905 PHOTOPRODUCTION OF PSEUDOSCALAR MESONS ON NUCLEONS AT HIGH ENERGIES, AND REGGE POLES. Rekalo, M. P. (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.), 6: 338-41(Nov. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 913-16(Nov. 15, 1967).

The consequences of the Regge-pole hypothesis for reactions of photoproduction of pseudoscalar mesons on nucleons are discussed. It is assumed that the resultant interaction constants obey the relations of exact SU(3) symmetry, and the corresponding constants of interaction of the tensor and vector mesons coincide. Cross section relations are obtained for the photoproduction of π, η, and K mesons. (L.B.S.)

17906 ON INFINITIES IN ELECTROMAGNETIC MASS DIFFERENCES TO ANY ORDER IN α. Olesen, P. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 20: 525-8(Mar. 4, 1968).

It is shown to any order in α that the electromagnetic mass difference between the charged and the neutral pion is at most logarithmically divergent, and a necessary and sufficient condition that the pion mass difference times the isovector form factor is finite to any order in α is derived. All results are valid whether or not perturbation theory makes sense. (auth)

17907 ANGULAR DISTRIBUTION OF POSITIVE PION PHOTOPRODUCTION FROM HYDROGEN. Shimoida, Hiroo (Tokyo Univ.); Yokomi, Hiroyuki. Progr. Theor. Phys. (Kyoto), 38: 1319-25(Dec. 1967).

The angular distribution of the positive pion in photoproduction is analyzed in the following form of cross section, $d\sigma/d\Omega = A + Bx + Cx^2 + D/(1 - vx) + E/(1 - vx)^2$, where v is cm velocity of pion, $x = \cos\theta_{cm}$, and E is calculated unambiguously from the retardation diagram. The four coefficients A, B, C and D are determined with a least square fit to almost all the data available for the laboratory photon energy E_γ = 180 to 500 MeV. These are compared with Chew, Goldberger, Low and Nambu's theory with Ball's correction to the pion-pion interaction. (auth)

17908 CALCULATION OF THE WIDTH OF THE $f^0 \to 2\gamma$ DECAY FROM THE DISPERSION SUM RULES. Radutskii, G. M. JETP Lett. (USSR) (Engl. Transl.), 6: 336-8(Nov. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 911-13(Nov. 15, 1967).

The dispersion sum rule for the amplitude of the reaction $\gamma + \gamma \to \pi^0 + \pi^0$ was used to calculate the width of the $f^0 \to 2\gamma$ decay. $\Gamma(f \to 2\gamma) = 0.02$ MeV was obtained, corresponding to approximately 0.02% of the total f-meson width. (L.B.S.)

17909 ELECTRON-ELECTRON SCATTERING CROSS SECTION INCLUDING POLARIZATION CORRELATIONS. Shieh, Shuang-Yuan (Lehigh Univ., Bethlehem, Pa.). Phys. Lett., 26B: 232(Jan. 22, 1968).

Electron-electron scattering cross sections are calculated, including the dependence on the helicities of both incoming and outgoing particles. (auth)

Weak

Refer also to abstracts 17894, 17951, and 18314.

17910 (JINR-P2-3647) ASIMPTOTICHESKOE RAVENSTVO SECHENII VZAIMODEISTVIYA NEITRINO I ANTINEITRINO S NUKLONOM. (Asymptotic Equality of the Cross Sections of Neutrino and Antineutrino Interaction With a Nucleon). Nguyen Thi Hong (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 16p. (In Russian). Dep.

Asymptotic equality of the cross sections of multiple hadron production by neutrino and antineutrino collisions with the nucleons is established. This equality is a consequence of analyticity of the amplitudes of the virtual Compton effect type and of a rather probable assumption on the behavior of these cross sections at high energies. (auth)

17911 (NYO-3829-14) K_{e4} DECAY AND π-π SCATTERING. Maksymowicz, Alexander (California Univ., Santa Cruz. Div. of Natural Sciences). (Pittsburgh Univ., Pa. Dept. of Physics). Sept. 1967. Contract AT(30-1)-3829. 9p. Dep. CFSTI.

A discussion is given of previous work on K_{e4} decay, which was proposed as a suitable process for determining the parameters of the $\pi + \pi$ interaction. Special attention is given to the assumptions involved, and restriction is made to the decay mode $K^+ \to \pi^+ + \pi^- + e^+ + \nu$. (J.F.P.)

17912 CURRENT ALGEBRA AND WEAK INTERACTIONS. Ioffe, B. L. (Academy of Sciences, USSR). pp 447-68 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

Some aspects of current algebra and its applications to weak interaction physics are discussed. The problem of neutral currents in hadron-lepton interactions is considered within the framework of the weak interaction theory with intermediate W-boson and the four-fermion interaction theory. New aspects which follow from the use of current algebra in the calculation of the radiative corrections to the weak interaction constant are briefly considered. The problem of checking the consequences of current algebra by means of perturbation theory is discussed. (L.B.S.)

17913 DENSITY ALGEBRAS AND THEIR SATURATION. Bjorken, J. D. (Stanford Univ., Calif.). pp 490-502 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

The sum rules for neutrino reactions and the related one for lepton electromagnetic scattering are interpreted on the basis of the "constituent" picture of the nucleon. The conditions under which the sum rules can be satisfied are discussed. (L.B.S.)

17914 RADIATIVE CORRECTION TO β-DECAY. Preparata, G. (Univ., Rome). pp 522-9 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

A brief review is given of the progress and new developments in the calculation of radiative corrections to β-decay. (L.B.S.)

17915 NONLEPTONIC K DECAYS. Itzykson, C.; Jacob, M.; Mahoux, G. (Centre d'Etudes Nucleaires, Saclay, France). Nuovo Cim. (1), Suppl., 5: 978-1013(1967).

The techniques of current algebra are applied to the study of $K \to 2\pi$ decay, where the essential result is the dominance of the $\Delta I = 1/2$ transition. The $K \to 3\pi$ decay is considered and the amplitude is related to the $K \to 2\pi$ amplitude. Assuming a simple behavior of the off-mass-shell amplitude, good agreement with experiment is obtained, not only for the total rate, but also for the energy spectrum of the pions. A brief discussion is given of the $K_1^0 - K_2^0$ mass difference. Finally, an analysis is made of nonleptonic K decays involving photons. (L.B.S.)

17916 PERATIZATION OF THE VERTEX IN THE THEORY OF WEAK INTERACTIONS THE WITH W-MESON. Hosek, J. (Nuclear Research Inst., Rez, Czech). Czech. J. Phys., 18: 222-32(1968).

The integral equation for the vertex with crossed boson lines is solved by the known peratization technique. In the zero energy approach some numerical corrections to the simple vertex are obtained and it is shown that higher order corrections cannot be neglected. The influence of these corrections on the cross section for the neutrino production of the W-meson in the nuclear field and on the W-mass is investigated. (auth)

17917 DECAY RATES OF $\Delta S = -\Delta Q$ TRANSITIONS AND POSSIBLE $\Delta S = 2$ LEPTONIC DECAYS. de Rafael, Eduardo; Goldhaber, Maurice (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 20: 522-5(Mar. 4, 1968).

Relations between possible $\Delta S = -\Delta Q$ decay rates of K^0-$\bar{K}^0$, K^+,

Σ^+, and Ξ^0 are given. A connection between $\Delta S = -\Delta Q$ and $\Delta S = 2$ leptonic decays is also suggested. (auth)

17918 CHARGE ASYMMETRIES. Fitch, Val L. Comments Nucl. Particle Phys., 2: 6-9(Jan.-Feb. 1968).

New results obtained from experiments at the Brookhaven AGS and the Stanford linear accelerator, which explicitly display CP violation in the decay $K_2^0 \rightarrow \pi^\mp + l^\pm + \nu$, are reviewed. Both experiments showed a lack of charge asymmetry. The question of the validity of the $\Delta S = \Delta Q$ rule in regard to the present experimental results is briefly considered. (L.B.S.)

17919 THE CURRENT × CURRENT HYPOTHESIS AND THE $\Delta S = \Delta Q$ RULE. Treiman, Sam. Comments Nucl. Particle Phys., 2: 18-21(Jan.-Feb. 1968).

A discussion is given on the master current × current picture of Feynman and Gell-Mann, in which a single master current, composed of a lepton part and a hadron part, interacts with itself. The existence of purely leptonic processes, the occurrence of nonleptonic $\Delta S = 1$ and $\Delta S = 0$ reactions, and the existence of $\Delta S = -\Delta Q$ semileptonic interactions are discussed. (L.B.S.)

17920 POLARIZATION PROPERTIES OF THE FREQUENCIES IN THE INTERSECTING LEPTON BEAMS. Romanov, Yu. I. (Inst. of Medical Radiology, Erevan). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 9, 44-8(1967). (In Russian).

Polarization properties of particles in crossed electron (positron, muon)—neutrino and antineutrino beams were investigated. The longitudinal spinor state of fermions was analyzed considering the two-component and the four-component neutrino theory. In the theory the four-component Dirac neutrino with zero mass the right-polarized neutrino and left-polarized antineutrino are bound by a muon field ($\nu_R \equiv \nu_\mu, \bar{\nu}_L \equiv \bar{\nu}_\mu$) and the left polarized neutrino and right-polarized antineutrino are bound by an electrical field ($\nu_L \equiv \nu_e, \bar{\nu}_R \equiv \bar{\nu}_e$), while in the two-component theory both neutrinos ν_e and ν_μ have a left-polarization. Calculations of total cross sections of elastic neutrino (antineutrino)—electron and muon scattering in the first approximation of the theory of perturbation in weak (V,A) interactions in the cms system of colliding particles established that in the event of (V—A) coupling of charged lepton currents the electrons (negative muons) participating in the examined processes have left polarization and positrons (positive muons) have the right one. The same conclusions were obtained in the investigation of the two-component neutrino theory in the electron neutrino conversion into μ neutrino and μ neutrino into l-neutrino: $\nu_\mu + e_L^- \rightleftharpoons \nu_e + \mu_L^-$, $\bar{\nu}_e + e_L^- \rightleftharpoons \bar{\nu}_\mu + \mu_L^-$, $\nu_e + e_R^+ \rightleftharpoons \nu\mu + \mu_R^+$, $\bar{\nu}_\mu + e_R^+ \rightarrow \bar{\nu}_e + \mu_R^+$. Other regularities were found in the investigation of inelastic $\nu e(\bar{\nu}e)$ and $\nu\mu(\bar{\nu}\mu)$ scatterings and annihilation and generation of electron—positron and muon pairs. (R.V.J.)

17921 NEUTRINO PAIRS FROM HOT STARS. Salpeter, Edwin E. Comments Nucl. Particle Phys., 2: 1-5(Jan.-Feb. 1968).

Three processes for the production of neutrino-antineutrino pairs in stellar interiors are considered: the photoneutrino reaction $\gamma + e \rightarrow e + \nu + \bar{\nu}$, pair annihilation $e + \bar{e} \rightarrow \nu + \bar{\nu}$, and spontaneous decay of a transverse plasmon. The total rate of energy loss into $\nu\bar{\nu}$ pairs due to these three processes combined is plotted against density at constant temperature. The question of possible astrophysical evidence for neutrino pair production is considered; the three kinds of stars discussed are the central stars of planetary nebulae, very hot white dwarfs, and supernova explosions. (L.B.S.)

17922 UNSUBTRACTED DISPERSION RELATIONS IN WEAK INTERACTIONS AND COMPOSITE PARTICLES. Kanki, Takeshi; Saito, Takesi (Osaka Univ.). Prog. Theor. Phys. (Kyoto), 38: 1361-8(Dec. 1967).

The $\pi \rightarrow \mu + \nu$ and baryon + antibaryon $\rightarrow \mu + \nu$ processes are investigated under the condition that a pion is a Regge particle. A somewhat simplified model is used, i.e., baryons have degenerate mass and only the baryon-antibaryon states are taken into account for the unitarity. It is found that the unsubtracted dispersion relation does not hold for the invariant amplitude of the $\pi \rightarrow \mu + \nu$ decay, and the eigenvalue restriction on the strong-interaction parameters, suggested by Nishijima, does not occur. These results are the immediate consequence of the Regge pion. The following properties of the Regge pion play a crucial role: The composite pion can couple only to one eigenchannel but not to many eigenchannels, and the improper vertex function with the pion off the mass shell (form factor) has a certain high-energy behavior. The amplitude of the baryon-antibaryon process can satisfy the unsubtracted dispersion relation even for the Regge pion. The partially conserved axial-vector current hypothesis is established if and only if the weak decay can occur through only the eigenchannel to which the pion be coupled. (auth)

17923 TEST OF BJORKEN'S ASYMPTOTIC FORMULA IN PERTURBATION THEORY. Vainshtein, A. I.; Ioffe, B. L. JETP Lett. (USSR) (Engl. Transl.), 6: 341-3(Nov. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 917-19(Nov. 15, 1967).

Two examples of W^+ boson scattering by a proton are considered in a field-theory model, in the g^2 approximation, in order to test the applicability of Bjorken's asymptotic formula to vector and axial currents in V-A theory. (L.B.S.)

17924 DETERMINATION OF PION SCATTERING LENGTHS FROM AN ANALYSIS OF THE EXPERIMENTAL $K \rightarrow 3\pi$ DECAY DATA. Anisovich, V. V.; Dakhno, L. G. JETP Lett. (USSR) (Engl. Transl.), 6: 334-6(Nov. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 907-11(Nov. 15, 1967).

Experimental data on the spectra for $K^+ \rightarrow \pi^0\pi^0\pi^+$ and $K_2^0 \rightarrow \pi^+\pi^-\pi^0$ decays with respect to ϵ ($\epsilon = 1 - (K_{11}^2/E)$, where K_{11} is the relative momenta of the pions and E is the kinetic energy released in the decay) are compared with theoretical formulas to determine possible values of pion scattering lengths. (L.B.S.)

17925 STRANGE LEPTONS. Weiner, Richard M. Phys. Rev. Lett., 20: 396-8(Feb. 19, 1968).

The consequences of the following two assumptions are discussed: (1) There exist strange leptons; (2) strangeness is conserved in all semileptonic interactions. These hypotheses could explain the absence of neutral currents in semileptonic processes and the $\Delta S = \Delta Q$ rule without assuming that the weak current transforms like a SU(3) octet. Experiments are proposed, well within the reach of present possibilities, to test these assumptions. (auth)

Strong (General)

Refer also to abstract 18035.

17926 FOUNDATION AND LIMITS OF DIFFRACTION THEORIES. Van Hove, L. (CERN, Geneva). pp 259-73 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

A brief review of the application of diffraction concepts to the theoretical interpretation of nuclear and hadron collisions is presented. Various nuclear and particle models are discussed and differential cross sections are shown. (J.F.P.)

17927 EXCHANGE REACTIONS IN LOW- AND HIGH-ENERGY PHYSICS. Dar, A. (Massachusetts Inst. of Tech., Cambridge). pp 274-310 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

Peripheral models with properly incorporated absorption effects as a common basis for the understanding of high- and low-energy reactions are advocated. The evolution of the peripheral model is followed, difficulties encountered in comparison with experimental data are pointed out, and a peripheral model is presented which is free of some defects of earlier absorptive peripheral models. (J.F.P.)

17928 INDEPENDENT QUARK MODEL. Lipkin, H. J. (Weizmann Inst. of Science, Rehovoth, Israel). pp 363-72 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

The quark model for elementary particles is discussed in analogy to models for nuclear structure and reactions. The point of view is taken that all criticism and careful analysis should be devoted to understanding those results which agree with experiment and to determine which assumptions of the model are necessary to obtain them and which are irrelevant. No attempt is made to give a coherent description. The quark model for hadron structure, the application to high-energy scattering, quark rearrangement in proton—antiproton annihilation into mesons, and decay processes are discussed. (J.F.P.)

17929 REGULARITIES ARISING IN THE COMPOSITE-HADRON PICTURE, IN TERMS OF A THEORY OF HIGH-ENERGY CURRENTS. Ne'eman, Y. (Tel-Aviv Univ., Israel). pp 382-90 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

A reformulation of the regularities described by the quark model in terms of a better-understood dynamical theory which could be implanted in the main body of particle physics rather than appearing as a replacement to be used for certain types of problems is suggested. The CHN hypothesis is reviewed. (J.F.P.)

17930 UPPER LIMIT OF THE NUMBER OF QUARKS IN SOME SOLIDS. Braginskii, V. B.; Zel'dovich, Ya. B.; Martynov, V. K.; Migulin, V. V. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 54: 91-5(Jan. 1968). (In Russian).

Three series of experiments are performed in a search of rare particles with noninteger electron charges, an improved method being employed. Statistically meaningful deviations of the charges from integral values were not observed in any of the experiments which means that there are less then 10^{-17} quarks per nucleon. Some difficulties of the method used are considered. Conclusions which can be drawn from these experiments regarding the structure of strongly interacting particles are discussed. (auth)

17931 PHENOMENOLOGICAL ANALYSES OF HIGH ENERGY SCATTERING. PART II. Bando, Masako (Kyoto Univ.); Morita, Katsusada; Yoshida, Toshihiro; (and others). Progr. Theor. Phys. (Kyoto), Suppl. No. 41-42, 374-422(1967).

The basic ideas underlying various phenomenological models that have been proposed to interpret experimental high-energy scattering data are briefly summarized, and their main results are given. The models discussed include: the optical model in high energy scattering; one-particle-exchange model and its variations; Regge pole model; symmetry approach to high energy scattering; various versions of the statistical theory; and the uncorrelated jet model. Tables and graphs are presented, showing the comparison of theory with experimental data. Rearrangement collisions and dispersion relation calculations are briefly discussed. 143 references are given. (L.B.S.)

17932 RELATIVISTIC WAVE EQUATION CONTAINING INTERNAL MOTION. Takabayasi, T. (Nagoya Univ., Japan). pp 413-26 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

The general viewpoint that a particle is originally internally structured to perform quasilocal internal movement in the physical Minkowski space-time is put forward and is exemplified as an approach to a unified description of hadrons. (L.B.S.)

17933 STRONG INTERACTION DYNAMICS. Blankenbecler, R. (Univ. of California, Santa Barbara). pp 559-604 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

Various topics which deal with on-shell and off-shell phenomena in strong interaction dynamics or kinematics are treated from a unified point of view, namely, the summation of Feynman diagrams. Some of the topics dealt with are: Regge pole origin, daughter trajectories, conspiracy, finite energy sum rules, bootstraps, and Reggions. Off-shell topics include O(4) symmetry, crossing symmetric Bethe–Salpeter equations, and the ladder approximation. (L.B.S.)

17934 DYNAMICS BASED ON INDEFINITELY RISING REGGE TRAJECTORIES. Mandelstam, S. (Univ. of California, Berkeley). pp 605-20 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

A possible dynamical scheme based on infinitely rising Regge trajectories is proposed, using the narrow resonance approximation in relativistic theory. The scheme is applied to obtain mesons as bound states of the nucleon-antinucleon system. (L.B.S.)

17935 CUTS IN THE ANGULAR MOMENTUM PLANE AND HIGH ENERGY ASYMPTOTIC BEHAVIOR. Gribov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). pp 621-33 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

The present state of the theory of strong interactions at very-high energies and fixed momentum transfers is discussed. The existence and importance of Regge poles in relativistic theory for the description of high energy processes is pointed out. An approach based on the analysis of asymptotic behavior of Feynman diagrams is described for determining the contribution of branch points generated by poles. Some results obtained using this approach are discussed. (L.B.S.)

17936 CHN ALGEBRA AND REGGE CUTS. Ne'eman, Yuval (State Univ. of New York, Stony Brook. Tel Aviv Univ., Israel). pp 634-43 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

Two conclusions concerning cuts in the complex L plane which can be derived from the application of Cabibbo–Horwitz–Niemann algebra are discussed. (L.B.S.)

17937 Z = 0 AND BOOTSTRAPS. Zachariasen, F. (California Inst. of Tech., Pasadena). pp 687-702 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

The possibility of formulating the bootstrap hypothesis based on Z = 0 within the framework of Lagrangian field theory is considered. An outline is first given of how the imposition of constraints on a field theory in the form of vanishing renormalization constants can change a particle from elementary to dynamical, considering the theory of two spinless particles, π and σ. The discussion is then extended to the bootstrap idea in Lagrangian field theory. (L.B.S.)

17938 QUARK STATE OF MATTER. Shishkin, G. V. (Inst. of Nuclear Energy, Minsk). Dokl. Akad. Nauk BSSR, 11: 897-900(Oct. 1967). (In Russian).

Under the assumption that quarks are parafermions, the conditions for the realization in nature of a quark state of matter were examined within the framework of the model of a superdense degenerate gas of elementary particles. In contrast to the work of V. I. Mal'ko and M. A. Markov, where the only channel of quark bonding with normal matter is quark–neutron $N \rightleftharpoons 3q$, it was assumed that the quark can be bound with any baryon $B \rightleftharpoons 3q$. The same quarks can be excited with parafermions. Calculation of all known baryon states leads to the conclusion that for the realization of a quark state of matter it is necessary that the quarks have a number of parafermion states $\underline{g}$ higher by an order of magnitude than assumed previously. If $\underline{g}$ has the value given previously then the quark state of matter is realized at matter densities higher by two orders of magnitude than assumed by Man'ko and Markov. (tr-auth)

17939 MASS TERM OF SUB-HADRONIC SYSTEMS. Maki, Ziro; Umemura, Isao (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 38: 1392-1400(Dec. 1967).

The mass term in a simple Lagrangian model for the sub-hadronic fields (urbaryons or quarks) is studied. In the case of chiral-type interactions the bare particle mass m_0 is estimated to be strikingly small under two essentially different approximations. The nonrelativistic treatment leads to $m_0 \approx \mu$ (the pion mass)/2 in the static limit. On the other hand, the soft pion limit with the use of commutator-saturation-approximation, which seems to be reasonable in the spirit of the PCAC relation yields a result $m_0 \approx \mu/2\sqrt{2}$. Physical implications of these results are also discussed. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 17924.

17940 (DESY–67/38) SUPERCONVERGENCE RELATIONS FOR $\bar{N} + N \rightarrow \pi + \rho$ AND $\bar{N} + N \rightarrow \pi + \omega$. Bartl, A. (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik); Widder, F. (Graz Univ. (Austria). Institut fuer Theoretische Physik). [1967]. 12p. Dep.

Superconvergence relations for $\bar{N} + N \rightarrow \pi + \rho$ and $\bar{N} + N \rightarrow \pi + \omega$ are considered which follow from high-energy behavior. Saturating these relations with a number of low-lying states one obtains $g_{\phi N}/g_{\omega N} \approx 0.06$, and $m_\omega = m_\rho$ and $g_{\rho\omega\pi} = 21\ (\text{GeV})^{-1}$ in good agreement with experiment. Assuming ρ-meson universality and vector meson dominance one obtains $g_{\rho N} = 2.8$, $g_{\omega N} = 6.4$, $f_{\rho N} = 10.3$ in agreement, and $f_{\omega N} = 4.0$ in disagreement with the results of a least-squares fit of low-energy N-N data. (auth)

17941 SOME REMARKS CONCERNING HIGH-ENERGY SCATTERING. Chou, T. T.; Yang, C. N. (State Univ. of New York, Stony Brook). pp 348-59 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

The usefulness of describing high-energy meson(π)–nucleon and nucleon–nucleon scattering in terms of the interaction of extended structures is emphasized. Then some speculative considerations, based on this idea, are reported concerning the form factors of nucleons and meson (π) and meson (π)−meson (π) scattering at high energies. (J.F.P.)

17942 HARD PIONS AND PION MASS DIFFERENCE. Schnitzer, H. J. (Brandeis Univ., Waltham, Mass.). pp 538-45 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.
See CONF-670824.

A technique for treating hard pions using Ward-Takahashi type identities is reported and illustrated for the case of $A_1 \rightarrow \rho\pi$ decay. Three and four point functions are considered in a chiral SU(2) × SU(2) theory. The technique is applied to the calculation of the $\pi^+ - \pi^0$ mass difference. (L.B.S.)

17943 EXISTENCE OF SOLUTIONS OF CROSSING-SYMMETRIC N/D EQUATIONS. Atkinson, David (Univ. of California, Berkeley). J. Math. Phys. (N.Y.), 8: 2281-96(Nov. 1967).

A fixed-point theorem is applied to the N/D equations of $\pi\pi$ scattering, for which crossing is satisfied exactly by the absorptive part of the amplitude, up to a finite, but arbitrary cut off. It is found that ghost-free solutions exist, if the subtraction constants are not too large, but that these solutions are not unique, since the Castillejo−Dalitz−Dyson ambiguity is not resolved by the requirement of crossing symmetry. (auth)

17944 π-π SCATTERING LENGTHS AND DISPERSION RELATIONS. Paver, N.; Verzegnassi, C. (Univ., Trieste, Italy). Phys. Lett., 26B: 388-91(Feb. 19, 1968).

Some numerical bounds on the π-π scattering lengths which follow from analyticity, unitarity and crossing symmetry of the scattering amplitude, combined with an effective range low-energy parametrization are discussed. The implications of the existence of a narrow σ resonance ($J = 0^+$, $T = 0$, $M \approx 430$ MeV) are also analyzed. (auth)

17945 HARD-PION CALCULATION OF π−π SCATTERING. Arnowitt, R.; Friedman, M. H.; Nath, P.; Suitor, R. (Northwestern Univ., Boston). Phys. Rev. Lett., 20: 475-8(Feb. 26, 1968).

A mass-shell current-algebra calculation of π-π scattering is given. The Weinberg scattering lengths and effective ranges are shown to be valid within a few percent. At the K meson mass, the essentially model-independent result $\delta^0 - \delta^2 \simeq 35°$ was obtained. The existing data at higher energies (up to 1 GeV) can be fitted by adjusting a model-dependent parameter. (auth)

17946 CALCULATION OF BOSON MASSES IN HIGHER NEW TAMM–DANCOFF-APPROXIMATION IN THE NONLINEAR SPINOR THEORY. Saller, H.; Duerr, H. P. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Naturforsch., 22A: 1819-24(Dec. 1967).

Eigenvalue equations of bosons in the second step of the New Tamm−Dancoff-approximation (NTD) are investigated in the Hermitean formulation of the nonlinear spinor theory. It is shown that three of the four derived equations lead to the same result, whereas one approximation is completely different and is supposed to give a useless result because the suppressed 6-point function contains essential parts of the considered 2-point function. It is possible by a factorization of the equations of the second iteration to calculate a local graph. By taking this graph into consideration the eigenvalues of spin-0-particles obtained in lowest NTD are slightly corrected. For comparison the same questions are discussed in case of the anharmonical oscillator. (auth)

17947 BOSON MASS EMPIRICS. Schwinger, Julian (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 20: 516-18 (Mar. 4, 1968).

A one-parameter mass formula that gives a reasonable account of the broken mass spectrum of the nine 1^+, nine 0^-, and nine 1^- particles is obtained on the basis of chiral symmetry and a specific hypothesis of initial nonuplet degeneracy. The accuracy of the empirical mass formula is significantly improved by the introduction of one additional parameter. (L.B.S.)

17948 COMMUTATION RELATIONS OF CURRENT AND MESON FIELDS. Abe, Mitue (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 38: 1419-20(1967).

It is possible to define the axial-vector current when one introduces pseudovector fields instead of the derivatives of pseudoscalar fields. The time component of the axial-vector current density is given in terms of the pseudovector field, and a massive gauge field is considered. Equal-time commutation relations between the time components of the currents are found. Taking both the vector current and the axial-vector as purely F-type the same current algebra is obtained as for the quark model and the chiral gauge formalism. (J.F.P.)

17949 NONRENORMALIZATION OF F_K/F_π. Lai, C. S. (Indiana Univ., Bloomington). Phys. Rev. Lett., 20: 509-10 (Mar. 4, 1968).

By solving the spectral-function sum rules consistently, the ratio F_K/F_π is found to be unity to the first order of SU(3)-breaking effect. (auth)

17950 WEINBERG SUM RULES, THE RATIO F_K/F_π AND K_A AND K* DECAYS. Srivastava, P. P. (CERN, Geneva). Phys. Lett., 26B: 233-5(Jan. 22, 1968).

Using Weinberg's first spectral sum rule in SU(3) × SU(3) while the second sum rule only in SU(2) × SU(2) the ratio F_K/F_π is calculated and the decays $K_A \rightarrow K^*\pi$ and $K^* \rightarrow K\pi$ are studied, treating pions soft in the sense $k^2 \rightarrow 0$. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 17941.

17951 (JINR–P2-3670) OB UCHETE ELEKTROMAGNITNYKH EFFEKTOV V DISPERSIONNYKH SOOTNOSHENIYAKH DLYA RASSEYANIYA VPERED. (On the Account of Electromagnetic Effects and Dispersion Relations for the Forward Scattering). Solov'ev, L. D.; Shchelkachev, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 18p. (In Russian). Dep.

The dispersion relations for the pion-nucleon forward scattering are written down taking into account the electromagnetic corrections. It is shown that these corrections need be considered while comparing the dispersion relations with the experimental data at high energies. Some theoretical models, used for finding the purely nuclear amplitude from the experiment, are discussed. (auth)

17952 DISPERSION SUM RULES AND THE STRUCTURE OF ELEMENTARY PARTICLES. Fubini, Sergio (Univ., Turin). pp 373-81 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.
From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

The idea of a systematic investigation of the relations between coupling constants and masses of isobars by means of general requirements like dispersion sum rules is considered. Results of the static model are discussed, and previous attempts are outlined in the framework of a full relativistic theory. (J.F.P.)

17953 REGGE EXCHANGE AMPLITUDES AND THE πN RESONANCE SPECTRUM. Barger, V. D. (Wisconsin Univ., Madison). pp 655-72 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.
See CONF-670824.

Some features of Regge exchange amplitudes that can be related to the πN bound state and resonance spectra are discussed. (L.B.S.)

17954 QUASI-TWO-BODY FINAL STATES PRODUCED IN π^+p INTERACTIONS BETWEEN 3 AND 4 GeV/c. Brown, David (Univ. of California, Berkeley); Gidal, George; Birge, Robert W.; Bacastow, Robert; Fung, Sun Yiu; Jackson, Warren; Pu, Robert. Phys. Rev. Lett., 19: 664-7(Sept. 11, 1967). (UCRL-17665).

Cross sections and angular distributions for the quasi−two-body final states $N^{*2+}\rho^0$, $N^{*2+}\omega^0$, and $N^{*2+}\eta^0$ were measured at five incident π^+ momenta between 3 and 4 GeV/c. These cross sections, when combined with results at higher momenta, indicate that the momentum dependence of the $N^{*2+}\rho^0$ cross section deviates from that expected for a meson-exchange reaction, and that there is shrinking of the diffraction peak. Dips in the production angular distributions are observed, similar to those observed in two-body final states. (auth)

17955 CONNECTION BETWEEN THE MARCHENKO FORMALISM AND N/D EQUATIONS: REGULAR INTERACTIONS. I. Cornille, Henri (Institut de Physique Nucleaire, Orsay, France). J. Math. Phys. (N.Y.), 8: 2268-81(Nov. 1967).

In potential scattering, the existence and meaning of the solutions of the N/D equations in the equivalent formulation f/f are studied. For S waves, considering only regular discontinuity $\mu\Delta(x)$, such that the resulting integral equation is of the Fredholm type, the corresponding Fredholm determinant $\mathcal{D}(\mu)$ is studied. It is remarked that the Marchenko formalism gives exactly the same resulting equation and then there is the possibility of interpreting in terms of local potentials. The connection between the nth trace of the kernel of the resulting integral equation and the nth term of the potential reconstructed from the discontinuity is shown. The connection between dispersion relation and the corresponding potential reconstructed from the discontinuity is given by the relation $\mathscr{D}(\mu) = \exp - (1/2) \int_0^\infty \int_r^\infty V(t,\mu)dt\, dr$. The study is limited to $|\mu|$ less than the smallest modulus root of $\mathscr{D}(\mu)$ where a perturbation expansion of the solution exists and it is shown that $V(r,\mu)$ is regular at $r = 0$. On the other hand, for Yukawa-type potentials where the inverse Laplace transform is $\lambda C(\alpha)$ the Fredholm determinant is $\exp(-\int_m^\infty \lambda C(\alpha)/\alpha^2\, d\alpha)$ and cannot vanish such that the corresponding solutions of the resulting integral equation exist always. (auth)

17956 BEHAVIOR OF THE DIFFRACTION MAXIMUM OF THE BARYON IN INELASTIC MESON–NUCLEON INTERACTIONS. Andreescu, Ileana; Besliu, Calin; Gavrilas, Mariana (Univ., Bucharest). Compt. Rend., Ser. A and B, 265: 1485-7(Dec. 18, 1967). (In French).

The capacity of the Roy model to explain the experimental data on the behavior of the diffraction maximum was investigated. The results showed that this model can conveniently describe the behavior of the slopes observed. Better agreement can probably be obtained by comparing the data of the quasi two-body channels with a similar model where the exchange of a small number of Regge poles, but larger than one, is taken into consideration. (J.S.R.)

17957 LATEST RESULTS ON PION–PROTON SCATTERING AT HIGH ENERGIES. Brandt, Siegmund (Univ., Heidelberg). Fortschr. Phys., 15: 551-623(1967). (In German).

A review is given of the present experimental and theoretical situation of pion-proton scattering. In elastic scattering three characteristics can be derived; the constants of the width of the forward scattering maxima shows the Regge-Pole theory in its original form to be doubtful. The forward scattering amplitude has a real part of approximately 30% in agreement with the latest disbursion theoretical calculations. A steep backward scattering maximum seems to occur only for the scattering of positive pions but not negative pions. A conspicuous property of the inelastic process is the grouping of the secondary particles into two channels which follows in the center of gravity system the directions of both incident particles. Very often these channels can be identified as resonance states. Theoretical assumptions on such processes are given in the form of the peripheral model which depends on the exchange of individual mesons between the incident particles. It was improved by various investigators by the introduction of empirical form factors or by consideration of the absorption of the low partial waves. Both varients however yield valid results only at average energies (3 to 8 BeV/c laboratory momentum of the incident pions). Whereas the agreement for processes with pion exchange is somewhat satisfactory, great deviations exist between theory and experiment for ρ meson exchange. Better agreement with experiment occurs in the case of calculations which consider the exchange of a Regge trajectory. For some processes the exchange of a baryon was considered. A completely different theoretical assumption is the coherent drop model which concedes the collision process not as particle exchange but as interaction between the colliding pion and the proton as the limits. (tr-auth)

17958 SPIN FLIP IN HIGH ENERGY ELASTIC πN SCATTERING. Michael, C. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Lett., 26B: 392-3(Feb. 19, 1968).

An upper limit on the magnitude of the spin flip amplitude in πN elastic scattering is obtained, and the small angle momentum transfer dependence of the reduced spin flip amplitude is found to be comparable with that of the nonflip amplitude. (auth)

17959 ON THE πN PHASE SHIFT IN THE ^{33}P STATE. Kinoshita, Kisei; Murai, Nobuyuki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 1402-4(Dec. 1967).

The case of the P_{33} phase shift for $\pi + N$ scattering is studied from the viewpoint that the discrepancy between calculations of πN as a bound state and the result of the phase shift analysis is due to a CDD pole which is considered to represent the effects of some inelastic channels. The result suggests that the origin of Δ is the CDD pole, and that the pure elastic interaction in the πN channel does not make a large contribution in producing Δ, but it lowers the level of the CDD pole. (J.F.P.)

17960 MOMENTUM SPACE CALCULATIONS ON THE REPULSIVE CORE OF NUCLEAR FORCES. Wada, Masanobu (Nihon Univ., Funabashi, Japan). Progr. Theor. Phys. (Kyoto), 38: 1406-8(Dec. 1967).

The problem of whether the repulsion due to the exchange of a neutral vector meson (meson (ω)) can be regarded as an origin of the repulsive core is studied. The results show that the repulsion due to the ω exchange is not strong enough to screen various short-distance interactions and indicate the existence of another mechanism such as the structural core to produce the repulsive core. It is also found that contributions from the nonstatic effects due to the three-meson exchange are attractive in $^1S_0$, and that the nonstatic effects in reproducing the energy-dependence of $\delta(^1S_0)$ are not very small, despite their attractive effects. (J.F.P.)

17961 PARTIAL WAVE AMPLITUDES OF THE REACTION $\pi^- + p \to \eta + n$. Sasaki, Shosuke; Takahashi, Junji; Ozaki, Kazuhiko (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 38: 1326-37 (Dec. 1967).

Energy dependent partial wave analyses for the reaction $\pi^- + p \to \eta + n$ are carried out with respect to S, P, D and F waves in the energy range 561 to 1300 MeV. Two different types of the solutions are obtained. In the first solution, the η-production peak is dominated by the S_{11} resonance with mass M = 1570 MeV, total width Γ^T = 140 MeV, branching ratios (S_{11} res. → πN)/(S_{11} res. → all) = 40% and (S_{11} res. → ηN)/(S_{11} res. → all) = 50%. In the second solution, it is dominated by the P_{11} resonance with M = 1580 MeV, Γ^T = 130 MeV, (P_{11} res. → πN)/(P_{11} res. → all) = 35% and (P_{11} res. → ηN)/(P_{11} res. → all) = 30%. This P_{11} resonance is a new one which is different from Roper's resonance. In this analysis the second solution is better fitting experimental data than the first solution. (auth)

17962 PHENOMENOLOGICAL ANALYSIS OF PION NUCLEON SCATTERING AT HIGH ENERGIES. Endo, Ichita; Ikeda, Miyo; Kawaguchi, Masaaki; Sumi, Yoshio (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 38: 1297-1318(Dec. 1967).

Pion nucleon scattering in the multi-GeV region is analyzed in a purely phenomenological way in the sense that any specific theoretical model is not introduced. The scattering amplitude including the spin flip part is appropriately parametrized and the numerical values of these parameters are determined. In particular, it is to be emphasized that the hitherto unknown parameter β (the real to imaginary ratio of the spin flip amplitude) is uniquely determined within the present experimental knowledge ($\beta^{(+)} = 0.7$ for the π^+p and $\beta^{(-)} = 0.8$ for the π^-p). Furthermore, an empirical formula for the scattering amplitude is proposed. This formula is valid for all angles and is able to explain most of the presently available data in the multi-GeV region. For example, polarization data on elastic scattering are fairly well reproduced. Complete phase shift analysis is also performed and behaviors of the phase shifts and the absorption parameters are discussed. (auth)

17963 K-MESON NUCLEON FORWARD DISPERSION RELATIONS AND THE EVALUATION OF THE COUPLING CONSTANTS. Ara, Gulshan; Rashid, A. M. Harun-ar (Atomic Energy Centre, Dacca, East Pakistan). Progr. Theor. Phys. (Kyoto), 38: 1338-46(Dec. 1967).

The forward scattering dispersion relations for the K-meson nucleon system are evaluated with a view to determining the coupling constants. Two different forms of dispersion relations as proposed by Igi are particularly convenient for this purpose. Using the most recent data on total cross sections and the zero-range scattering lengths in the evaluation of the unphysical continuum, reasonable values of the coupling constants are obtained. (auth)

17964 A MODEL OF THE NUCLEON AND THE P_{11} RESONANCE AS A BOUND STATE OF A HIDDEN CHANNEL. Uehara, Masayuki (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto), 38: 1347-60(Dec. 1967).

A simple model is proposed for the nucleon and the P_{11} resonance, which explains the main features in the P_{11} state of the πN channel. It is indicated that the large inelasticity of the P_{11} state is not the origin of the resonance but the result of it. It is assumed in this model that there is a hidden channel involving a strongly bound state and its coupling to the πN channel generates the two particle states. The nucleon appears as if it were an elementary particle, provided only the πN channel is considered. Analyses are based on a decomposition of a partial wave amplitude into two parts, one representing a particle part and the other a background part. As to this point it is shown that an argument by Michael on the S_{11} state is not necessarily correct. (auth)

17965 UPPER LIMIT OF ELEMENTARY LENGTH. Kirzhnits, D. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 238-40(Oct. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 774-6(Oct. 1, 1967).

The estimate of Lindenbaum for the elementary length (a quantity determining the dimensions of the space–time region in which violation of the general principles of elementary-particle theory is possible) is considered. This estimate was derived from a comparison of forward $\pi + p$ scattering data and dispersion relations. The interaction $\pi^- + p \to$ unphysical fermion is discussed. It is concluded that the estimate of Lindenbaum $l < 0.7(10)^{-13}$ cm, although obtained from an unproven formula, is nonetheless not very inaccurate. (J.F.P.)

17966 NEUTRON AND PROTON AS COMPOSITE ELEMENTARY PARTICLES. Kakinuma, Usaku. Sci. Pap. Inst. Phys. Chem. Res. (Tokyo), 61: 39-44(Sept. 1967).

As was described previously, the electron in the ideal state has a structure consisting of a core, an intermediate singular field and an ordinary e.m. field. The nature of the singular field is clarified to the effect that it acts like a classical field, except for the difference in the value of the light velocity. When an electron and a positron happen to approach each other, both singular fields undergo contraction, increasing the mass but retaining the size and spin of their cores. In such a way the neutron is constituted from an electron and a positron, and the proton from one electron and two positrons. Some principles on which these composite elementary particles are made up are put forward and a suggestion regarding the appearance of mesotron as an intermediate product is presented. (auth)

17967 A POSSIBLE EXPLANATION OF THE Λ TO Σ RATIO IN THE ISOSPIN-1 S-WAVE $\bar{K}$ N REACTION IN A QUARK MODEL DESCRIPTION. Renard, F. M. (Laboratoire de Physique Theoretique et Hautes Energies, Orsay, France). Phys. Lett., 26B: 226-8(Jan. 22, 1968).

A proposal is given for explaining the discrepancy between the calculation of the parameter ϵ in the quark model and its experimental value. In addition to the single quark amplitude a diquark amplitude of the backwards-scattering type is considered; its value is determined independently from $K^- + p \rightarrow \Sigma + \pi$ cross sections; the prediction for ϵ agrees then with experiment, but is very sensitive to the low energy $\bar{K} + p$ parameters. (auth)

17968 VALIDITY OF THE INTERFERENCE MODEL FOR πN SCATTERING. Chiu, C. B. (CERN, Geneva); Stirling, A. V. Phys. Lett., 26B: 236-40(Jan. 22, 1968).

It is shown that the interference model does not account correctly for some features of the πN data between 2 and 6 GeV/c. (auth)

17969 DETERMINATION OF K* AND K** REGGE PARAMETERS AND SU(3)-SYMMETRY BREAKING. Sarma, K. V. L.; Renninger, G. H. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev. Lett., 20: 399-401(Feb. 19, 1968).

In an attempt to determine the intercepts of the K* (1^-) and K** (2^+) Regge trajectories from total cross-section data, it is found that significant deviations from SU(3) symmetry have to be considered. These deviations are accounted for by assuming that the Pomeranchuk-Regge residue has a small I = 0 octet component apart from the usual SU(3)-singlet term. (auth)

17970 PHASE CONTOURS OF COLLISION AMPLITUDES. Chiu, Charles B. (CERN, Geneva); Eden, Richard J.; Tan, Chung-I. Phys. Rev. Lett., 20: 406-8(Feb. 19, 1968). (UCRL-17952).

A brief discussion is given of the following topics: (1) properties of phase contours, (2) phase contours for pion-nucleon scattering below 1.4 GeV, (3) phase contours in a Regge model for picn-nucleon scattering, and (4) the use of phase contours for studying consistency between resonance poles, zeros, and high-energy behavior in a crossing symmetric model. (L.B.S.)

17971 STUDY OF SOME PERIPHERAL PROCESSES IN PION-NUCLEON SCATTERING. Pinon, Ramon Jr. Providence, Brown Univ., 1966. 155p.

Thesis.

Some peripheral processes in π-N scattering are studied. First, the reaction $\pi + N \rightarrow \pi + \pi + N$ at incident pion momentum 1.25 BeV/c and 1.59 BeV/c is investigated for small momentum transfer and for dipion mass around the ρ resonance region. Predictions based on the pion as a Regge pole are compared with those of the pion as an elementary particle. It is found that both cases give similar results. Second, the mass and angular distributions of the $\pi^-\pi^+$ system, produced in the reaction $\pi^- + \rho \rightarrow \pi^- + \pi^+ + N$, are examined. It is pointed out that the sharp peak observed over the broad ρ^0 peak in the $\pi^-\pi^+$ mass distribution can be explained as due to the electromagnetic decay of ω into $\pi^-\pi^+$, where the ω is produced via ρ exchange. The observed asymmetric $\pi^-\pi^+$ angular distribution is explained in terms of a strong s-wave $I = 0$ $\pi - \pi$ interaction. This interaction can be represented by a constant s-wave $I = 0$ phase shift ~60°, or by an s-wave resonance with the position very near the ρ mass. A small d-wave $I = 0$ contribution is also taken into account. It is found that the ω decay amplitude does not interfere with the ρ^0 production amplitude. Finally, the one-particle-exchange-model (OPEM), together with elastic unitarity, is applied to low-energy π-N scattering. N, N*, ρ, and σ ($J = 0$, $I = 0$, $\pi - \pi$ resonance, $m_\sigma \sim 420$ MeV) exchanges are considered only, and the masses and coupling constant of these particles are taken as known parameters. Low-energy p, d, f, and g-wave phase shifts are then calculated using a recently suggested approximation technique. The calculated phase shifts are compared with some of the current π-N phase shift analyses. It is concluded that the small π-N phase shifts may be qualitatively understood in terms of elastic unitarity and the exchange forces taken; however, for the large phase shifts, a better knowledge of short range forces and inelastic effects is needed. (Disser. Abstr.)

Strong (Baryon No. ≥ 2)

17972 (INR-P-831/VII/PL) $^6He_{\Lambda\Lambda}$ WITH NONLOCAL SEPARABLE INTERACTIONS WITH HARD SHELL Λ-Λ REPULSION. Dabrowski, J.; Dworzecka, M.; Trych, E. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 15p. Dep.

The problem of $^6He_{\Lambda\Lambda}$ treated as a $2\Lambda + \alpha$ system is solved exactly with a Yamaguchi nonlocal separable Λ-α potential, $V_{\Lambda\alpha}$, and a nonlocal separable Λ-Λ potential, $V_{\Lambda\Lambda}$, consisting of a long range attractive part plus a repulsive shell of radius c. The parameters of $V_{\Lambda\alpha}$ and $V_{\Lambda\Lambda}$ are adjusted to made the potentials equivalent to the local potentials $V_{\Lambda\alpha}$ and $V_{\Lambda\Lambda}$/with hard core radius r_c/discussed recently by Tang and Herndon. Numerical results for $B_{\Lambda\Lambda}$/$^6He_{\Lambda\Lambda}$/show that to get agreement with the experimental value of $B_{\Lambda\Lambda}$ one has to choose $c < r_c$. (auth)

17973 HYPERNUCLEAR SPECTROSCOPY. Bodmer, A. R. (Argonne National Lab., Ill. Univ. of Illinois, Chicago). pp 60-87 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

The discussion of hypernuclear spectroscopy covers theoretical models of the ΛN and the $\Lambda\Lambda$ interactions, phenomenological Λ nuclear interactions, $\Lambda\Lambda$ hypernuclei and the $\Lambda\Lambda$ interaction, and p-shell hypernuclei. (J.F.P.)

17974 MULTIPLE DIFFRACTION THEORY OF HIGH-ENERGY COLLISIONS. Glauber, R. J. (CERN, Geneva). pp 311-38 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

It is indicated that the analysis of collision experiments involving nuclei can be carried out in fairly simple terms and that it furnishes information about the elementary particle interactions as well as about nuclear structure. The analysis presented is based on the application of diffraction theory to collisions taking place within the nucleus. Also some experiments which show interesting phenomena easily and directly explained by the theory are discussed. (J.F.P.)

17975 PROPERTIES OF VELOCITY-DEPENDENT POTENTIALS. Ferreira, Erasmo M. (Univ. Central de Venezuela, Caracas. Centro Brasileiro de Pesquisas Fisica, Rio de Janeiro); Guillen, Nilo; Sesma, Javier. J. Math. Phys. (N.Y.), 8: 2243-9(Nov. 1967).

Properties of the solutions of the Schroedinger equation with a velocity-dependent potential are studied. Particular attention is given to the examination of the singularities of the differential equation. In the particular cases of one dimension and of the $l = 0$ partial wave of a spherically symmetric problem, a simple correspondence is found between the velocity-dependent problem and a static one. (auth)

17976 PARTICLE INSTABILITY OF $^3_\Lambda n$. Jaffe, A. I.; Reiner, A. S. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Lett., 26B: 351-2(Feb. 19, 1968).

The binding energy of $^3_\Lambda H$ was computed using a charge independent Λ-N interaction derived from low-energy scattering data and was found to agree with experiment. The same forces do not lead to a bound $^3_\Lambda n$. (auth)

17977 NUCLEAR FORCES. II. Feshbach, Herman; Kerman, Arthur K. Comments Nucl. Particle Phys., 2: 22-7(Jan.-Feb. 1968).

The boson-exchange theory of nuclear forces is reviewed, and the form of the nucleon-nucleon potential is indicated. (C.E.S.)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 18042.

17978 (JINR-P2-3668) SLEDSTVIYA CPT-INVARIANTNOSTI I EKSPERIMENT. (The Consequences of the CPT-Invariance and an Experiment). Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 23p. (In Russian). Dep.

A review is presented of the state of the CPT-invariance testing. The conclusions of the CPT-invariance on the mass equality, the lifetimes and magnetic moments of particles and their antiparticles are repeated. Experimental data for various particles are given. An expression for the $K^+ \rightarrow \pi^+\pi^0$ decay amplitudes is obtained in the absence of the CPT-invariance. It is stressed that the phase relation (30) is sensitive to the possible deviations from the CPT-invariance. (auth)

17979 CLEBSCH-GORDAN COEFFICIENTS OF THE SYMMETRIC REPRESENTATION OF SU_n GROUPS. Alishauskas, S. I.; Yutsis, A. P. (Inst. of Physics and Mathematics, Vilnyus, USSR. Kapsukas State Univ.; Vilna). Dokl. Akad. Nauk SSSR, 177: 61-4(Nov.-Dec. 1967). (In Russian).

Studying the direct derivation of an irreducible representation of the SU_n groups, expressed by the Clebsch-Gordan (C-G) series, a method was developed for the isoscolar factors of C-G coefficients through the product of $n - 2$ factors, each of which depends on the parameters of SU_k and $U_1 \times SU_{k-1}$($k = 3,4, \ldots. n$). Thus, the symmetrical representation is designated as the irreducible representation with Young's scheme, consisting of a single row of determinants or their contragradients. Such a Young's scheme consists of $n - 1$ or $k - 1$ rows for the SR_k subgroup. The derivation presented indicates that the method makes it possible to express the C-G coefficients of the symmetrical representation of the $SU_n \prod_{k=2}^{n} C_k$ groups, whereby C_k designates the C-G coefficients of the SU_2 group, and C_k with $k \geq 3$ the H_k or G_k factors, respectively, which are equal to the C-G coefficents of the SU_2 group. (TTT)

17980 GOLDSTONE THEOREM. Kibble, T. W. B. (Imperial Coll. of Science and Tech., London. Rochester Univ., N. Y.). pp 278-304 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

Certain aspects of broken symmetries which have a fairly direct connection with the Goldstone theorem are discussed. An attempt is made to formulate and prove the theorem in a general form applicable both to the nonrelativistic and relativistic situations, and to illustrate its application by discussing a number of particular models. (L.B.S.)

17981 BROKEN SYMMETRIES AND THE GOLDSTONE THEOREM IN AXIOMATIC FIELD THEORY. Kastler, D. (Aix-Marseilles Univ., France). pp 305-27 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

Following a brief discussion of generalities on spontaneously broken symmetries, the following topics are discussed: the covariant representation generated by an invariant state; ergodic states and spontaneously broken symmetries; the Goldstone theorem; relativistic theories with a conserved covariant current; nonrelativistic theories (superquantized Schroedinger equation); algebraic theory; and the strong relativistic Goldstone theorem. (L.B.S.)

17982 MATRIX PRODUCTS AND THE EXPLICIT 3, 6, 9, AND 12-j COEFFICIENTS OF THE REGULAR REPRESENTATION OF SU(n). Kaplan, L. M.; Resnikoff, M. (Univ. of Maryland, College Park). J. Math. Phys. (N.Y.), 8: 2194-2205(Nov. 1967).

The explicit Wigner coefficients are determined for the direct product of regular representations, $(N) \otimes (N) = 2(N) + \ldots$, of SU(n), where $N = n^2 - 1$. Triple products $C_m C_i C_m = \alpha F_i + \beta D_i$, and higher-order products are calculated where C_i may be F_i or D_i, the $N \times N$ Hermitian matrices of the regular representation, and m is summed. The coefficients α, β are shown to be 6-j symbols, and higher-order products yield the explicit 9-j, 12-j symbols. A theorem concerning (3p)-j coefficients is proved. (auth)

17983 SUBSTITUTION GROUP AND MIRROR REFLECTION SYMMETRY IN SPECIAL UNITARY GROUPS. Alisauskas, S. J. (Inst. of Physics and Mathematics, Vilnius, USSR); Jucys, A. P. J. Math. Phys. (N.Y.), 8: 2250-5(Nov. 1967).

The substitutions leaving the character of the representation of the group SU_n invariant are considered. The phases induced by these substitutions on the basis functions are established. The substitution giving the contragrediency transformation was found. This transformation is interpreted as the reflection of the subspace of commuting operators and the corresponding coordinate systems with respect to the rest subspace. The application of the substitution group to the resolution of multiplicity problem in the case of SU_3 is demonstrated. (auth)

17984 MASSLESS PARTICLES FOLLOWING SYMMETRY BREAKING. Katz, A.; Frishman, Y. (Weizmann Inst. of Science, Rehovoth, Israel). Nuovo Cim. (1), Suppl., 5: 749-85(1967).

The various concepts and ideas involved in the formulation of sufficient conditions for the appearance of massless particles following symmetry breaking are reviewed and analyzed. A definition is given of a broken symmetry, which also defines massless particles; it is shown by means of an example in the ferromagnet model that the existence of massless particles is not implied in this definition. Generators of infinitesimal transformations are defined and discussed, and broken symmetry is redefined in terms of the infinitesimal transformations. Discussions are then presented on massless particles and the spectrum, spurious states, and expansion of the generator as an integral over a density. A number of sets of sufficient conditions for the existence of massless particles are presented, and a few examples which illustrate the way in which the symmetry breaking condition is realized in different cases are given. (L.B.S.)

17985 CLEBSCH-GORDAN SERIES FOR THE CLASSICAL RANK-TWO GROUPS AND SU_4. Gruber, B. (Duke Univ., Durham, N. C.); Zaccaria, F. Nuovo Cim. (1), Suppl., 5: 914-36 (1967).

Expressions are given for the Clebsch-Gordan series for the groups SU_3, SO_5, SO_4, Sp_4, G_2, and SU_4, which correspond to a straightforward generalization of the Clebsch-Gordan series for SU_2. (L.B.S.)

17986 MULTILINEAR COUPLINGS IN THE EIGHT-FOLD WAY. Esteve, A. (Consejo Superior de Investigaciones Cientificas, Madrid); Redondo, J. L.; Tiemblo, A. Nuovo Cim. (1), Suppl., 5: 968-77(1967).

The discussion of multilinear couplings in the eight-fold way includes trilinear couplings, quadrilinear couplings, and fifth-order invariants. (L.B.S.)

17987 CONCEPT OF WAVE FUNCTION AND THE IRREDUCIBLE REPRESENTATIONS OF THE POINCARE GROUP. Nilsson, J.; Beskow, A. (Inst. of Theoretical Physics, Gothenburg, Sweden). Ark. Fys., 34: 307-24(1967).

Starting from the unitary irreducible representations of the Poincare group appropriate amplitudes for particles of arbitrary mass and spin were constructed. The transformation properties under Lorentz transformations were derived and the role played by the non-unitary finite-dimensional representation of the homogeneous Lorentz group is clearly demonstrated. In the case of free systems the explicit dependence of these amplitudes on the parameters of the Poincare group is given and it was established that they satisfy the Klein-Gordon equation. For the case of spin ½ amplitudes the Dirac equation was derived under quite general conditions and it was indicated how to proceed for arbitrary spin. For free systems the present formalism offers a consistent method to derive the usual equations of motion for arbitrary spin from first principles. The amplitudes were given in terms of well-defined state vectors representing the system. For interacting systems the formalism is still valid but contains some unknown amplitudes. Although no complete dynamical scheme is available at present prescribing on how to compute these amplitudes the methods which were developed in this paper still seem to offer the most natural basis for a phenomenological description of particle systems. (auth) (Swed)

17988 SOME REMARKS ON THE DECOMPOSITION OF A UNITARY REPRESENTATION OF THE LORENTZ GROUP WITH RESPECT TO REPRESENTATIONS OF NON-COMPACT SUBGROUP. Stroem, S. (Inst. of Theoretical Physics, Gothenburg, Sweden). Ark. Fys., 34: 215-25(1967).

It is shown how infinitesimal methods can be used in decomposing a unitary irreducible representation of the Lorentz group, belonging to the main series, with respect to unitary representation of a noncompact subgroup. Two cases are considered, in which the noncompact subgroup is chosen as the three-dimensional Lorentz group and the two-dimensional Euclidean group respectively. The connection with the global approach is discussed. (auth) (Swed)

17989 BRANCHING RULES FOR SOME REPRESENTATIONS OF THE GROUP SU_6. Navon, A. (Univ. of Montreal); Patera, J. Nuovo Cim. (1), Suppl., 5: 963-7(1967).

Tables are presented of all possible embeddings of simple Lie groups into SU(6), and of the branching rules induced by the representations of SU(6) of dimensions 15, 20, 21, 35, and 56. (auth)

17990 COUPLING PROBLEM FOR U(p,q) LADDER REPRESENTATIONS. I. Anderson, R. L.; Fischer, J.; Raczka, R. (International Centre for Theoretical Physics, Trieste, Italy). Proc. Roy. Soc. (London), Ser. A, 302: 491-500(Jan. 23, 1968).

The local and the global properties of ladder representations are considered. Several properties of the tensor product of two ladder representations are investigated and the Clebsch–Gordan coefficients for the ladder representations of the U(1,1) group are presented. (auth)

17991 UNITARY SYMMETRY. Charap, J. M.; Jones, R. B.; Williams, P. G. (Queen Marys Coll., London). Rep. Progr. Phys., 30: 227-83(1967).

Starting from the elementary notions of gauge invariance and charge conservation, the ideas of symmetry groups in elementary particle physics are developed, and a description of the unitary symmetry SU(3) is presented. The consequences of symmetries are described first in the more familiar context of isotopic spin, SU(2), and then applied to SU(3). In particular, the multiplet structure is described, and the way that a specified form of symmetry breaking leads to mass formulae. Particular attention is also paid to the role of the currents related to the generators of the group in the description of weak interactions. Higher symmetries like SU(6) and its generalizations are also outlined. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 17997.

17992 RELATION BETWEEN THE VIOLATION OF CP INVARIANCE IN MESON(K^0) DECAY AND STRANGENESS NONCONSERVATION. Grib, A. A. Vestn. Leningrad. Univ., No. 16, Ser. Fiz. Khim., No. 3, 172-3(Aug. 1967). (In Russian).

Operators of strangeness and CP-transformation are investigated from the point of view of Ekstein's geometric theory of charge. The breaking of the strangeness conservation is shown to lead to the change in CP-operator form. (auth)

17993 UNITARY SYMMETRY CLASSIFICATION OF LEPTONS. Ivanenko, D. D.; Naumov, A. I.; Startsev, A. A.; Frolov, B. N. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 9, 49-53(1967). (In Russian).

The hadrons unitary symmetry is considered to be isotopic. However, a certain similarity was observed between the isospin T and hypercharge Y and the ordinary spin J and baryon number B. In fact there are two empirical ratios: $2T + Y = 0 \pmod 2$ and $2J + B = 0 \pmod 2$. This parallelism and the tendencies of including baryon number operator into the generator ensemble of a certain simple die group lead to the assumption that the hadrons must have a strongly disturbed symmetry based on the group $SU_3(J,B)$. The analysis of this assumed symmetry and its combination with the ordinary unitary group SU resulted, in the past, only in a new particle classification and did not contribute anything to the known SU group. However, an attempt of using the SU group for light particle (lepton and photon) classifications revealed quite new moments. An attempt was made of using new approach for light particle classification using the SU multiplets. (R.V.J.)

17994 SUPERCONDUCTIVITY MODEL WITH CHIRAL SU(3) x SU(3) SYMMETRY PROPERTIES AND WEAK DECAYS OF ELEMENTARY PARTICLES. Koyama, Hideyuki (Univ. of Osaka Prefecture). Progr. Theor. Phys. (Kyoto), 38: 1369-91 (Dec. 1967).

The dynamical model of the pion-nucleon system, originally proposed by Nambu and Jona–Lasinio on the basis of an analogy with superconductivity, is extended to a Sakata triplet system. The Lagrangian with four-fermion interactions is assumed to be invariant under the chiral SU(3) × SU(3) group except for the small bare masses ($M_N^{(0)} \neq M_\Lambda^{(0)}$) of the nucleons and the lamda. Characteristic features of the physical masses and the strong interactions, in particular the large mass splittings of the octet mesons, are explained as results from the superconductivity mechanism working among bare baryons. Introducing in addition the weak four-fermion interactions among bare baryons and leptons, the weak decays of the physical baryons and mesons: $\pi \rightarrow \mu\nu$, $K \rightarrow \mu\nu$ and $\Lambda \rightarrow N\pi$, are investigated. It is shown in an explicit way that the bare Cabibbo angle is unaffected by renormalization of the strong interactions in contrast to the large shifts among the masses. The amplitudes for the nonleptonic decay $\Lambda \rightarrow N\pi$ are derived in a form similar to the results from a meson-pole dominance model and are in agreement with the experimental data. (auth)

17995 SYMMETRY BREAKING IN AXIAL-VECTOR SPECTRAL-FUNCTION SUM RULES. Oakes, R. J. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Lett., 20: 513-15 (Mar. 4, 1968).

Weinberg's first sum rule applied to the axial-vector currents is shown to split into two separately valid sum rules if the usual assumptions concerning SU(3) mixing are adopted. New relations among masses, coupling constants, and mixing angles are obtained in the meson-dominance approximation, e.g., $F_K/F_\pi = 1$, and the implications are discussed. (auth)

Applications (Strong)

17996 (KFKI-1/1968) WHO IS AFRAID OF W? Domokos, G.; Suranyi, P. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Jan. 5, 1968. 15p. Dep.

The SL(2,C) classification of Regge trajectories is extended to nonzero energies. Regge trajectories can be classified according to a "broken" SL(2,C) algebra, each "Regge-particle" being a superposition of a few irreducible representations of SL(2,C). A "mass formula" is derived to describe Regge trajectories which belong to one SL(2,C) family. The Δ-family turns out to be exchange-degenerate to a good approximation. The known nucleon trajectories can be fitted into one SL(2,C) family well described by the mass formula. The mass formula predicts several new resonances, some of them without parity partners. Evidence is put forward for the existence of a new family of nucleon Regge trajectories. (auth)

17997 HADRON PROPERTIES FROM NON-COMPACT DYNAMICAL GROUPS. Barut, A. O. (Univ. of Colorado, Boulder). pp 383-93 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

It is shown how the unitary representation of the group SO(4,2) or SU(2,2) group is used to correlate the following hadron properties: mass spectrum; decay rates; absolute value of the magnetic moment; and functional dependence of the form factors. (L.B.S.)

17998 REPRESENTATIONS OF O(3,1) AND REGGE DAUGHTER-POLES. Iverson, G. J. (Univ. of Adelaide). Phys. Lett., 26B: 229-31 (Jan. 22, 1968).

Unitary representations of O(3,1) in a J_{03}, J_{12} basis are investigated. The analysis leads to a verification of the daughter-pole hypothesis in a simple and exact manner. (auth)

Field Theories

General

17999 SOLUTION OF EHRENFEST'S PARADOX FOR A RELATIVISTIC ROTATING DISK. Cavalleri, G. (CISE, Milan). Nuovo Cim. (10), 53B: 415-32(Feb. 11, 1968).

Ehrenfest's paradox concerns the passage of a circular disk from rest to a rotating motion, examined by an inertial observer at rest with the center of the disk. For this observer, Lorentz' contraction acts only on the periphery and not on the radius of the disk, hence the ratio of the circumference to the radius should be less than 2π, thus violating the Euclidean geometry of the observer. It is here shown that Ehrenfest's paradox cannot be solved from a purely kinematical point of view, despite previous attempts. It follows that the relativistic kinematics for extended bodies is not generally self-consistent. The solution of the paradox (and of all problems involving nontranslatory motions) is intrinsically dynamical, because of the inertial forces and the theoretical nonexistence of a rigid material. However this explanation is not sufficient. It must be verified that elastic dilatation overcomes Lorentz' contraction. In the opposite case, radial compressive stresses should rise, with consequent radial instabilities. A thin disk should bend and the effect of the radial centrifugal field should be different from the effect due to a locally equal gravitational field, thus violating Einstein's equivalence principle. The following criterion is given. If, in the case of a rotating hoop having the maximum degree of rigidity in agreement with special relativity, the difference between elastic dilatation and Lorentz' contraction is a positive monotonic function of radius R for any value of angular velocity ω, there is no Ehrenfest's paradox. It is proved that this occurs by taking the correct stress-strain relation, which leads to a sound velocity equal to light velocity c. For $v = \omega R \rightarrow c$, the material of the hoop becomes like a photon gas and this answers some, who consider as a worrying point the limitation of the radius of a rotating body. The limitation of the velocities measured by a rotating observer is explained in the same way. (auth)

Quantum Field Theory

Refer also to abstracts 17886, 18019, 18037, and 18041.

18000 FIELD THEORY AS A GUIDE TO THE STRONG INTERACTIONS. Feynman, R. P. (California Inst. of Tech., Pasadena). pp 111-27 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.
See CONF-670824.

The problem of finding the dynamic laws of the strongly interacting particles which are guided by field theory is discussed from the point of view of Gell-Mann. (L.B.S.)

18001 BACK TO THE SOURCE. Schwinger, J. S. (Harvard Univ., Cambridge, Mass.). pp 128-56 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.
See CONF-670824.

The general idea of the theory of sources is first explained by an analogy with the self-consistent procedure used in the study of atomic phenomena. The source concept is then discussed in more detail, showing that it is a potent conceptual procedure, a unified attitude, and a calculational tool that avoids all the complications of other techniques. (L.B.S.)

18002 SPACE-TIME PICTURE OF ELEMENTARY PARTICLES. Katayama, Y. (Kyoto Univ., Japan). pp 157-77 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.
See CONF-670824.

The possibility of describing elementary particles as quantum mechanical objects extended in space and time is investigated. A possible formulation is presented of an approach to construct a fully convergent theory in which the space time extension of the particles results in cutoff factors sufficient for suppressing all sorts of divergences. In this approach an interpretation must be given of internal quantum numbers characterizing each kind of elementary particle in terms of the internal structure and motion of an extended particle. (L.B.S.)

18003 OLD AND NEW IDEAS IN FIELD THEORY. Kallen, G. (Lund Univ., Sweden). pp 178-84 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.
See CONF-670824.

The papers discussed by Schwinger and by Katayama and Yukawa on "new approaches to field theory" are summarized. (L.B.S.)

18004 PROGRESS IN THE FOUNDATIONS OF QUANTUM FIELD THEORY. Wightman, A. S. (Princeton Univ., N. J.). pp 187-232 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.
See CONF-670824.

A review is given on two topics in which important progress has recently been made: the canonical formalism and the existence of solutions in non-trivial model field theories. (L.B.S.)

18005 SOME PROBLEMS IN QUANTUM FIELD THEORY. Haag, R. (Univ., Hamburg). pp 233-43 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.
See CONF-670824.

Three formulations of quantum field theory are briefly reviewed—the strict field-theoretical language, local operator rings, and local C^* algebras. Some unsolved problems in each are discussed. (L.B.S.)

18006 ERGODIC ACTIONS OF THE EUCLIDEAN GROUP AND THE CANONICAL COMMUTATION RELATIONS. Mackey, G. W. (Harvard Univ., Cambridge, Mass.). pp 265-74 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.
See CONF-670824.

An approach to the field quantization problem is discussed. In particular, the canonical relations are replaced by an assumption involving Euclidean invariance, and it is shown that the problem produced by the nonuniqueness of the solutions of these relations turns into a well-known problem in ergodic theory. (L.B.S.)

18007 UNSYMMETRICAL VACUUM IN ELEMENTARY PARTICLE PHYSICS. Duerr, H. P. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). pp 328-43 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.
See CONF-670824.

The unsymmetrical vacuum and the Goldstone theory is discussed from the point of view of arriving at a better understanding of the origin of the approximate conservation laws in elementary particle physics and the corresponding symmetries of the elementary mass spectrum. (L.B.S.)

18008 SOME REMARKS ON INFINITE-COMPONENT FIELDS. Todorov, I. T. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 394-401 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.
See CONF-670824.

The discussion on infinite-component fields includes some remarks on spin and statistics, Majorana equations, and various attempts to include internal degrees of freedom such as charge and isospin within this framework. (L.B.S.)

18009 FIELD ALGEBRA AND PHENOMENOLOGICAL LAGRANGIAN. Lee, B. W. (State Univ. of New York, Stony Brook). pp 546-56 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.
See CONF-670824.

Recent activities on the phenomenological Lagrangian approach to current-field algebra are reviewed. Particular attention is given to an explanation of what the approach is, what it is designed to do, and what the calculational rules are. Some new results are also reported on the π^+-π^0 mass difference and the radiative correction to the pion β-decay. (L.B.S.)

18010 GEOMETRIZATION OF A COMPLEX SCALAR FIELD. II. ANALYSIS. Penney, R. (Ford Motor Co., Dearborn, Mich.). J. Math. Phys. (N.Y.), 8: 2297-2301 (Nov. 1967).

The necessary and sufficient conditions that a Ricci tensor should represent the energy tensor of a complex scalar field are given for the general nonnull case. The complexion gradient of the field is determined only to within a sign by the Ricci tensor, unlike the case of the electromagnetic problem. The physical content of a field which corresponds to massless "pions" is expressed entirely in geometric terms within the Rainich scheme. (auth)

18011 MATHEMATICAL STRUCTURE OF RELATIVISTIC QUANTUM FIELD THEORY. Yahya, Q. A. M. M. (Univ. of Dacca, East Pakistan). J. Natur. Sci. Math., 7: 7-15 (Apr. 1967).

The structure of relativistic quantum field theory from classical field equation to the mathematical view point is briefly reviewed. Some theorems valid for every field theory satisfying the axioms are discussed. The review is based on earlier work of Prof. Wightmann. (auth)

18012 CONSISTENT HIGHER-SPIN WAVE EQUATIONS. Dowker, J. S. (Univ. of Manchester, Eng.). Nuovo Cim. (1), Suppl., 5: 734-8 (1967).

A higher-spin-theory is proposed which is an extension of that given by Dirac to a form which remains consistent when interactions are included. The proposed equations are written as the system of sets of relations between representations of the homogeneous group. (L.B.S.)

18013 THE OPERATOR FORMULATION OF QUANTUM ELECTRODYNAMICS IN LANDAU GAUGE. Lukierski, J. (Univ., Wroclaw). Nuovo Cim. (1), Suppl., 5: 739-48 (1967).

The formulation of quantum electrodynamics on the Landau gauge is treated within the three-dimensional formalism, and it is shown that the space of states contains four kinds of photons. Following the construction of four-potentials, the four-momentum operator is constructed and the problem of removing the negative metric by means of subsidiary condition is discussed. The unitary transformation corresponding to the operator-gauge transformation is performed. (L.B.S.)

18014 INTERRELATIONSHIPS OF QUANTAL AND CLASSICAL SPIN-PARTICLE THEORIES. Plahte, E. (Agricultural Coll. of Norway, Vollebekk). Nuovo Cim. (1), Suppl., 5: 944-53 (1967).

A consistent dequantization of the Dirac-Pauli equation is performed within the framework of the conventional interpretation in order to obtain the equation of motion representing its classical analog. (L.B.S.)

18015 ON THE FIELD THEORETIC FUNCTIONAL CALCULUS FOR THE ANHARMONIC OSCILLATOR. II. Schuler, W.; Stumpf, H. (Univ., Tuebingen, Ger.). Z. Naturforsch., 22A: 1842-65(Dec. 1967).

The theory of solution for quantum field functional equations is developed for a suitable test problem of quantum mechanics. The anharmonic oscillator is described in a field theoretic fashion. Its functional equations are derived, and these equations are symmetrized due to physical conditions. The expansion of the physical functionals into series of base functionals is discussed and a convenient notation for the operator representation is introduced. The representation of the functional equation for an expansion into Dyson base functionals is given. Functionals are approximated by expansions with only a finite number of terms and the resulting equations are prepared for integration. The integration of the resulting equations for N = 2 and N = 4 is discussed in detail so that one finally obtains eigenvalue equations which contain only integrals to be solved. Technical details are derived. (auth)

18016 INTERPRETATION OF ELECTRODYNAMICS AS A CONSEQUENCE OF QUANTUM THEORY. **Zel'dovich, Ya. B.** (Inst. of Applied Mathematics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 345-7(Nov. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 922-5(Nov. 15, 1967).

Starting from an expression for the action in terms of particles and fields, a theory is considered whereas in quantum theory the field acts not only on the particles but also on the vacuum. The discussion is based on a generalization of an idea developed for gravitation theory to the case of the electromagnetic field. The essence of the proposed interpretation is that in electrodynamics as well as in gravitation the field terms represent vacuum correction with a total cutoff momentum, which is an externally specified constant of the theory. (L.B.S.)

Gravitation and General Relativity

Refer also to abstracts 17195, 17269, 17292, 17309, 17328, 17339, and 17878.

18017 (LA-3839) A RELATIVITY NOTEBOOK FOR MONTE CARLO PRACTICE. **Everett, C. J.** (Los Alamos Scientific Lab., N. Mex.). Dec. 14, 1967. Contract W-7405-eng-36. 181p. Dep. CFSTI.

The basic ideas and formulas of special relativity are organized into a form convenient for Monte Carlo treatment of relativistic systems of point particles. The dynamics of a point particle, classes of systems, transmutations of systems, and cross sections are discussed. (J.F.P.)

18018 VACUUM QUANTUM FLUCTUATIONS IN CURVED SPACE AND THE THEORY OF GRAVITATION. **Sakharov, A. D.** Dokl. Akad. Nauk SSSR, 177: 70-1(Nov.-Dec. 1967). (In Russian).

On the basis of Einstein's theory of gravitation, which postulates the dependence of space-time action on the curvature, a new hypothesis is considered, identifying the fundamental equation concerning the general force which prevents the curvature of the space, with the change of the quantum fluctuations of the vacuum in the curved space. Thus, the metric elasticity of space is considered as a special effect of the shifting of the level. The derivations indicated that the gravitational interaction depends on the masses of free particles and the laws governing their motion and probably also on the "cutoff pulse." This approach is similar to that used in quantum electrodynamics. (TTT)

18019 INTERACTION OF GRAVITATION FIELDS WITH QUANTUM ELECTROMAGNETIC AND DIRAC FIELDS. **Minkevich, A. V.** (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk, No. 3, 97-105(1967). (In Russian).

The nature of the origin of the gravitational displacement of particles in the general theory of relativity and on the basis of an elementary examination in the framework of Newton's theory of gravitation with use of the hypothesis of working photons is essentially different. The physical consequences of the use of the working photon hypotheses in the framework of a relativistic examination are investigated. On the basis of a theoretical field approach, an examination was made of the interaction of gravitational fields with quantum electromagnetic and Dirac fields in the linear approximation according to the gravitational potential. It was shown that the use of the hypothesis of the working photon leads to a difference with respect to the general theory of relativity: in the behavior of the photon in a static gravitational field and also in the dependence of the radiation frequency of hydrogen atoms on the gravitational potential. Although the usual results were obtained for the gravitational displacement of the frequency, the motion of the atomic clock does not agree with the general theory of relativity. Experiments to confirm the theoretical results were discussed. (tr-auth)

18020 TETRAD FORMULATION OF JUNCTION CONDITIONS IN GENERAL RELATIVITY. **Estabrook, Frank B.; Wahlquist, Hugo D.** (California Inst. of Tech., Pasadena). J. Math. Phys. (N.Y.), 8: 2302-8(Nov. 1967).

Explicit and complete junction conditions across internal boundaries are found for the Ricci rotation coefficients and Riemann tensor components in an arbitrary reference tetrad frame; the reference frame may be discontinuous at the boundary. The allowed jumps in inertial and gravitational field dyadics are given for the case of normal boundary motion. When the reference frame is chosen to be comoving with the matter distribution on either side of the boundary, the junction conditions include such immediately physical results as the relativistic Rankine–Hugoniot relations. It is expected that use of such comoving reference frames will be important in finding discontinuous exact solutions. (auth)

18021 STATIC DISTRIBUTION OF CHARGED DUST IN GENERAL RELATIVITY. **De, Utpal Kumar** (Univ. of Kalyani, West Bengal, India); **Raychaudhuri, A. K.** Proc. Roy. Soc. (London), Ser. A, 303: 97-101(Feb., 1968).

Charged dust distributions in equilibrium are considered. If the dust is uniformly charged (i.e., if the ratio of the charge density to the matter density is constant) or if the surfaces of the dust distributions are equipotential surfaces and inside these surfaces there is no hole or pocket of alien matter, then there exists a simple relation between g_{00} and ϕ; the electrostatic potential and the charge density must be equal to the matter density. Further, in this case the whole system of field equations can be reduced to a single Laplace equation in the empty space outside, and to a nonlinear modified Poisson equation within the charged dust distributions. (auth)

18022 ON THE ROLE OF BOSE STATISTICS AT GRAVITATIONAL TRANSITIONS. **Halpern, L.** (Univ. of Stockholm). Ark. Fys., 35: 57-69(1968).

Interaction of the gravitational field with another boson field preferably that of the photon is discussed. The effects of the Boson character of the fields on the production of gravitational radiation were investigated. The spontaneous emission of gravitational Bremsstrahlung of photons was compared with the radiation stimulated by photons and gravitons. Difficulties which occur in the infrared regions in connection with these processes are discussed. The results lead to the interpretation that there exist possible conditions which are such that the free graviton cannot be distinguished from the photon. Experiments are suggested to investigate such a possibility. The mixed photon-graviton Compton effect was analyzed to demonstrate the gage dependence of the results and to estimate the significance of the process for the production of gravitational radiation. (auth) (Swed)

18023 MULTIPOLE EXPANSIONS FOR STATIONARY FIELDS IN GENERAL RELATIVITY. **van der Burg, M. G. J.** (Univ. of York, Eng.). Proc. Roy. Soc. (London), Ser. A, 303: 37-44(Feb. 1968).

Stationary solutions of the Einstein field equations with no spatial symmetries are considered in order to discover the number of arbitrary constants, corresponding to the moments of the source in the Newtonian field, which appear in the solution. It is shown that the stationary field contains twice the number of moments which appear in the static field, apart from the mass term which appears singly. These additional moments are essentially angular momentum terms, which in Newtonian theory make no contribution to the field. (auth)

18024 CHRONOMETRIC INVARIANCE AND THE PROBLEM OF GRAVITATIONAL ENERGY. **Mitskevich, N. V.; Mukhika, Khose D.** Dokl. Akad. Nauk SSSR, 176: 809-11(Oct. 1, 1967). (In Russian).

The relativistic laws clearly possess 4-dimensional space-time symmetry. However, the separateness of time is a fundamental feature of the physical world in view of which the concept of a reference system plays an important role. These reference systems are related to each other by transformations. Energy is an observable quantity, and it is natural to consider it as a time scalar. Integration of a time scalar quantity of an element of energy $dE = w_\sigma dS_\sigma$ over a 3-volume (over a space-like hypersurface whose element is dS_σ) is a proper operation, since the transfer of a 3-scalar in a 3-dimensional world isolated by the hypersurface is single-valued. One of the main difficulties in the formulation of the concept of integral energy in Riemann space due to the absence of far parallelism during transfer of tensors is removed in this way. It is shown that this program can be carried out even in the most general case. (TTT)

18025 POSSIBILITY OF GENERATION AND DETECTION OF GRAVITATIONAL RAYS. **Nagibarov, V. R.; Kopvillem, U. Kh.**

(Kazan Physico-Technological Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 9, 66-72(1967). (In Russian).

Production of a super-emitting gravitational and nonemitting electromagnetic states in a system of N-particles with a discrete spectrum using laser techniques and particle excitation in two-quantum operation was analyzed. The necessary conditions and parameters capable of generating optical and γ frequency forces in coherent gravitational waves were found. The principal design of the coherent gravitational beam collector is included. (R.V.J.)

18026 NATURE OF GRAVITATIONAL FIELD. Polievktov-Nikoladze, N. M. (Tbilisi State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 308-11(Nov. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 874-6(Nov. 1, 1967).

It is shown that with some refinement the metric principle (as such) admits of direct empirical verification. The refinement consists of assuming that the equations of gravitation correspond to the variational principle and obey rigorously the equivalence principle in the sense that the gravitational interaction is included in the Lagrangian of the matter (a metric interaction is inadmissible in which the equivalence principle is satisfied only with a specified degree of accuracy). In such a case the gravitational equations, regardless of their concrete form, lead to geodetic equations of motion for a particle in a gravitational field, which in turn lead to certain general conclusions. (J.F.P.)

18027 COSMOLOGICAL CONSTANT AND ELEMENTARY PARTICLES. Zel'dovich, Ya. B. (Inst. of Applied Mathematics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 316-17(Nov. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 883-4(Nov. 1, 1967).

The hypothesis that the equations of general relativity contain the cosmological constant Λ is considered. The theory in which vacuum properties are obtained from elementary particle theories is discussed. It is emphasized that astronomic observations must provide the evidence regarding the quantity Λ, and that it cannot be regarded as proved that $\Lambda \neq 0$. (J.F.P.)

18028 MASS OF THE GRAVITON. Polievktov-Nikoladze, N. M. (Tbilisi State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 331-4(Nov. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 905-7(Nov. 15, 1967).

It is shown that a non-zero rest mass of the anomalous graviton is incompatible with the metric equations of gravitation. (L.B.S.)

18029 ON POSITIVE-DEFINITENESS OF INERTIAL MASS, NONPOSITIVE-DEFINITENESS OF ELECTROMAGNETIC COUPLING AND THE MACH PRINCIPLE FROM GENERAL RELATIVITY. Sachs, M. (State Univ. of New York, Buffalo). Nuovo Cim. (10), 53B: 398-414(Feb. 11, 1968).

A particular mapping between time-reversed spinor fields in a Riemannian space is shown to necessarily lead to the generally covariant form of the Dirac equation. The derived field that plays the role of inertial mass in these equations is found to be a positive-definite function of the space-time co-ordinates. The imposition of gauge invariance on the spinor field equations, which is necessitated by the requirement to incorporate an equation of continuity in the formalism, is shown to lead to the necessary incorporation of a nonpositive-definite vector coupling term in the same field equations. The latter term is identified with the electromagnetic four-potential. It is then concluded from the derived structure of this formalism that gravitational forces can only be attractive while electromagnetic forces can be attractive or repulsive, in agreement with the experimental facts. The results so obtained are used in an application to demonstrate that a finite neutrino mass would imply that it must also have a nonzero electromagnetic coupling with charged matter. It is shown that the mathematical results of this analysis of inertial mass are entirely compatible with the interpretation according to the Mach principle. (auth)

18030 QUASI-INERTIA AND GRAVITATION. Teitler, S. (Naval Research Lab., Washington, D. C. Univ. of Copenhagen). Nuovo Cim. (10), 53B: 329-45(Feb. 11, 1968).

The geometric basis for the effects of gravitation is traced from the relative orientation structure of pseudo-orthonormal basis vectors on the world line of a material point of interest. The effect of gravitation is specified by a principle of quasi-inertia. The relative basis structure is viewed in terms of a field frame and the effects of gravitation are then expressed by means of a force in this fixed (quasi-inertial) frame. This frame is generalized to a regional space and equations of motion for the nongeodesic particle motion under the influence of gravitation are obtained. The conditions that this regional space actually has the physical significance of an observer space are used to arrive at field equations. These field equations are used to solve for tensor gravitational fields entering in the equations of motion for the case applicable to the gravitational red-shift, the mercury perihelion shift, and the deflection of light by the sun. The usual Einstein-Schwarzschild results are obtained. The unity of the present view of the geometric basis of the effects of gravitation and that of the Lorentz force as described by Riesz are also briefly indicated. (auth)

18031 DETECTION OF GRAVITATIONAL WAVES BY ELECTROMAGNETIC RADIATION. Heintzmann, H. (Univ., Cologne). Z. Phys., 210: 380-90(1968).

A method of detecting gravitational waves through their interaction with charged particles is given. Known exact solutions representing radiation are discussed. (auth)

Scattering Theory

Refer also to abstract 17879.

18032 (JINR-P2-3662) "KLASSICHESKAYA" I KVANTOVAYA S-MATRITSA V DVUKHMERNOI MODELI POLYA BORNA-INFEL'DA. (Classic and Quantum S-Matrix in the Two-Dimensional Born-Infeld Model). Barbashov, B. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 22p. (In Russian). Dep.

A method of determining the S-matrix for the nonlinear Born–Infeld field is considered in two-dimensional space x,t. The classic S-matrix, which converts the incident waves into the outgoing ones, is determined on the basis of an exact solution of the classic equation of this field. It is shown that in a certain approximation on the "nonlinearity" parameter the g-quantum S-matrix coincides with the "classic" one. In this approximation the S-matrix leads only to the elastic scattering processes. (auth)

18033 ON THE QUANTUM MECHANICAL N-BODY PROBLEM. Hepp, K. (Eidgenossische Technische Hochschule, Zurich). pp 244-51 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

Recent progress is presented on the qualitative structure of quantum systems with a large, finite number of degrees of freedom, interacting by short range forces. The qualitative solutions of the Schroedinger N-body problem and, in principle, of the ghostless Galilei invariant form of the Lee model of Levy-Leblond are outlined. (L.B.S.)

18034 ANALYTIC PROPERTIES OF SCATTERING AMPLITUDES FROM FIELD THEORY AND UNITARITY. Martin, A. (CERN, Geneva. Brookhaven National Lab., Upton, N. Y.). pp 252-7 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

Examples of physical results obtained from analyticity are noted: the forward pion-nucleon dispersion relations, the Pomeranchuk theorem, and restrictions on ππ scattering. The progress made in the analyticity domain of reaction amplitudes is reviewed. The existing information derived from positivity, elastic unitarity in the elastic region and crossing are summarized. (L.B.S.)

18035 INVARIANT DECOMPOSITION OF THE SCATTERING AMPLITUDE FOR PARTICLES OF HIGHER SPINS. Fubini, S. (Inst. of Physics, Turin). pp 644-54 of Proceedings of the 1967 International Conference on Particles and Fields. Hagen, C. R.; Guralnik, G.; Mathur, V. S. (eds.). New York, Interscience Publishers, 1967.

See CONF-670824.

A method is proposed for studying invariant functions in the theory of scattering, which is different from the usual helicity representation and which is useful for the current algebra and superconvergence coupling scheme. The relation between Regge poles and Khuri poles is shown as an application of the invariant decomposition. (L.B.S.)

18036 ANALYTICITY IN THE POTENTIAL STRENGTH. Masson, D. (Univ. of Toronto, Can.). J. Math. Phys. (N.Y.), 8: 2308-14(Nov. 1967).

The partial-wave S-matrix element is examined as a function of potential strength g. It is shown to be related to a series of Stieltjes in g. This is accomplished by looking at the zeros of the Jost function below threshold and the zeros and poles of tan δ_l above threshold. The series of Stieltjes property is used to establish the convergence of the Padé approximate method of summing the Born series. (auth)

18037 NONRELATIVISTIC AND RELATIVISTIC THEORIES OF TWO-BODY COMPOUND SYSTEMS. Ciafaloni, M. (Scuola Normale Superiore, Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Nuovo Cim. (1), Suppl., 5: 680-733(1967).

A discussion is presented of the general features and the main results obtained from the application of the spectral method in the coupling constant to the study of composite systems, i.e., bound states, antibound states, and resonances. Two models are considered, namely, potential scattering and the Bethe–Salpeter equation for $\lambda\phi^3$ theory treated in the ladder approximation. (L.B.S.)

18038 CONSTRUCTION OF SOLVABLE POTENTIALS AND SOME ASPECTS OF REGULARIZATION OF SINGULAR POTENTIALS. Vasudevan, R.; Venkatesan, K.; Jagannathan, G. (MATSCIENCE, Madras). Nuovo Cim. (1), Suppl., 5: 621-41(1967).

Solvable potentials are constructed, both singular and nonsingular, for the Schroedinger equation and also for the Klein–Gordon equation and the Dirac equation in the nonrelativistic limit. The regularization program for a class of singular potentials is also discussed. (L.B.S.)

18039 WAVE PACKETS IN RELATIVISTIC S-MATRIX THEORY. Loefgren, P. (Univ. of Stockholm). Ark. Fys., 35: 177-95(1968).

An exposition of relativistic S-matrix theory in terms of wave functions is presented. The concept of direct integral of Hilbert spaces is introduced in order to be able to work with a sharp four-momentum in a mathematically rigorous way. The S-operator is supposed to work on wave functions as an integral operator, whose kernel is the R-function. The transformation formula, the unitarity relation and the relation between the R-function and the differential cross section were derived. (auth) (Swed)

18040 CROSSING SYMMETRY AND BETHE–SALPETER EQUATION. Pindor, M. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 871-4(1967).

The formal lack of the crossing symmetry of the Bethe–Salpeter equation for the scattering amplitude M(p,q,S) is considered. Spin and charge indices are neglected, and masses are assumed to be equal. (J.F.P.)

18041 COMPOSITENESS CRITERIA OF PARTICLES IN QUANTUM FIELD THEORY AND S-MATRIX THEORY. Hayashi, Kenji; Hirayama, Minoru; Muta, Taizo; Seto, Noriaki; Shirafuji, Takeshi (Kyoto Univ.). Fortschr. Phys., 15: 625-60(1967).

A review is given of recent developments in compositeness arguments of particles in the framework of Lagrangian field theory and S-matrix theory. (auth)

18042 POINCARE AND LORENTZ INVARIANT EXPANSIONS OF RELATIVE AMPLITUDES. Sheftel, M.; Smorodinsky, J.; Winternitz, P. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 26B: 241-4(Jan. 22, 1968).

Double expansions of amplitudes in terms of the representations of the Lorentz group are discussed and their relation to relativistic phase shift analysis in terms of various little groups of the Poincaré group is established. (auth)

Particle Accelerators

Refer also to abstracts 16907, 16931, 17563, 17717, 18123, 18310, and 18557.

18043 (CERN-68-2) RADIOLYTIC CORROSION AND RELATED PROBLEMS IN THE COOLING WATER CIRCUITS OF HIGH-ENERGY PARTICLE ACCELERATORS. Hoyer, F.; Bourges, M.; Deltenre, R. (European Organization for Nuclear Research, Geneva (Switzerland)). Jan. 25, 1968. 20p. Dep.

Copper(II) ion production by radiolytic effects in the rf-cooling water circuit of the CERN 600-MeV synchrocyclotron was determined. Corrosion inhibitors, such as hydrazine and benzotriazole were added to the water in a circuit-simulator and the corrosion rate under irradiation conditions was studied. Later, these inhibitors were directly applied to the water of the rf-cooling circuit and their behavior was examined. Beam intensity, water flow rate, available copper surface, and temperature were kept constant and the dependence of copper(II) ion production on irradiation time was determined. Through this experiment it was possible to derive a law $C \sim \sqrt{t}$ for the time (t) dependence of the increase of copper(II) ion concentration (C). It could be shown too, that corrosions of copper surfaces in an irradiated water circuit follows a law which is different from that for normal corrosion in pure demineralized (but oxygen-containing) water. Benzotriazole, as an inhibitor, behaved as if the available copper surface had been reduced. For hydrazine, the inhibitive effect was disturbed by the quick copper-catalyzed decomposition of this compound. (auth)

18044 (NP-17272) STUDIE UEBER EINEN SUPRALEITENDEN PROTONEN-LINEARBESCHLEUNIGER IM GeV-BEREICH. (Studies on a Superconducting Proton Linear Accelerator in GeV Range). (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). July 1967. 236p. (In German). Dep.

A proposal for the construction of a superconducting proton linear accelerator in the GeV range is presented. The report was prepared to serve as the basis for further experimental and theoretical studies. The scientific principles on which the accelerator is based are reviewed. Preliminary design parameters of the accelerator are given. Cost studies and construction plans are briefly described. (J.S.R.)

18045 (NP-17324) SKHEMA ODNOOBOROTNOI INZHEKTSII V BEZZHELEZNOM SINKHROTRONE BSB. (A Single-Turn Injection System for the BSB Iron-Free Synchrotron). Mostovoi, Yu. A.; Samoilov, I. M.; Sokolov, A. A. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1965. 18p. (In Russian). Dep.

Certain engineering difficulties with single-turn injection in the BSB synchrotron were solved, resulting in the design of an efficient single-turn injector with a revolution time of 1×10^{-6} sec. The physical and engineering parameters of the inflector system are described. (auth)

18046 PREPARATION OF URANIUM LAYERS BY HIGH VOLTAGE ELECTROPHORESIS. Verdingh, V.; Lauer, K. F. (EURATOM, Geel, Belg.). Nucl. Instrum. Methods, 60: 125-8 (Mar. 15, 1968).

A method is described that allows the preparation of thick and homogeneous uranium oxide layers on metallic backings. The layers were used in neutron physics experiments. (auth)

18047 STABILITY OF COLLIDING BEAMS. Balbekov, V. I.; Kolomenskii, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 37: 2021-30(Nov. 1967). (In Russian).

The effect of electromagnetic interaction of colliding beams on their stability has been investigated theoretically. The use of a kinetic equation makes it possible to solve this problem regardless of the number of bunches or the nature of their oscillations. It is shown that, aside from the motion of the bunch centers, oscillations of the higher moments, such as size and shape, are possible. Each oscillation type is characterized by its natural frequency. The coincidence of these frequencies gives rise to instability, which is a special case of coupling resonance. In earlier works, only first-order resonance, coincident with the oscillations of the center, was investigated. The present study covers resonances of the higher orders as well. It is shown that betatron frequency spread renders the beam unstable. Wall instability, resulting from interaction of beams with reflections in nonideally conductive walls of a vacuum chamber, has been dealt with in a similar way. It is shown that its increment remains similar to that of a single beam, and that the interaction changes the frequency of oscillations, which may ultimately result in a substantial decrease of the instability threshold. Most of the results are shown to depend upon the average interaction strength of the bunches. The periodic nature of collisions is important only inasmuch as it is accompanied by a parametric resonance of betatron oscillations. The requirement for parametric resonance is that an integral number of betatron half-waves be laid off between the collisions. Basic results are presented for the wall instability of an azimuthally inhomogeneous beam. (ATD)

18048 ION ENERGY SPREAD OF A UNIVERSAL HIGH CURRENT ION SOURCE FOR IONS FROM SOLIDS. Krimmel, E. F. (Univ., Tuebingen, Ger.). Nucl. Instrum. Methods, 60: 231-2 (Mar. 15, 1968).

A recently developed universal ion source for ions produced from solids emits ion currents at the present up to 26 mA by applied acceleration potentials of 50 kV. The energy spread of the emitted ions was measured to have an upper limit of several eV only. (auth)

18049 INSTALLATION OF A CAE 510 WITH A TANDEM VAN DE GRAAF. Bianchi, G.; Corge, M. C. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 120, 95-108(Nov. 1967). (In French).

A data acquisition and processing system has been in service for more than a year with the Service de Physique Nucléaire at the Saclay Nuclear Research Center for nuclear physics experiments. The system, a CAE 510, is used in on-line acquisition and processing, and a special control console has been added, with a visualizing unit and a program calling panel for master and operational routines of the key-board type. Experience gained to date has been fruitful and indicative of future prospects. (auth)

18050 SIMULTANEOUS DATA ACQUISITION AND PROCESSING SYSTEM USING A C.A.E. 510 COMPUTER. Fernier, Ph.; Labbe, J.; Laget, J. P. (CEA, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 120, 71-82(Nov. 1967). (In French).

A data processing system including on-line computing and used in multiparameter analysis experiments with the 12 MeV Tandem Accelerator is described. The monitor program is capable of directing the various operational routines without interrupting the acquisition in real time of nuclear data. The routines can process either currently acquired data or data acquired during earlier experiments. A control console facilitates routine, and is equipped with visualizing and indicating facilities for the presentation of sequences in progress. (auth)

18051 CALCULATION OF THE POSITON MATCHING OPTICAL SYSTEM IN A LINEAR ACCELERATOR. Leboutet, H.; Aucouturier, J. Ann. Radioelec., 22: 225-35(July 1967). (In French).

In order to obtain the best possible yield of accelerated positions in a linear accelerator it is necessary to calculate the shape of the magnetic field which will give best matching at the accelerator entry. To find the yield of positions per electron the overlap of the phase volumes of the different elements is calculated. A numerical application gives the orders of magnitude of the expected results on an accelerator now under construction. (auth)

18052 SCATTERING OF A PARTICLE BEAM ARRIVING AT NORMAL INCIDENCE ON THE BORDER OF A PLATE. Durand, Alain (Univ., Rennes, France). Compt. Rend., Ser. A and B, 265: 1396-9(Dec. 18, 1967). (In French).

A beam of particles arriving under normal incidence on the border of a plate is considered. The angular and distance distributions of these particles after scattering by the plate were studied. (tr-auth)

18053 THEORY OF THE FOCUSSING OF IONIC RAYS BY A HOMOGENEOUS MAGNETIC FIELD WHOSE SHARPLY DEFINED BOUNDARIES ARE CIRCULAR LINES. I. Bogomolov, E. A.; Saulit, V. R. Vestn. Leningrad. Univ., No. 16, Ser. Fiz. Khim., No. 3, 81-102(Aug. 1967). (In Russian).

The theory of the focussing of charged particles by a homogeneous magnetic field whose sharply defined boundaries are circular lines is presented. The effect of the fringing field on the focussing is taken into consideration. The general problems are considered. (auth)

18054 MEASUREMENT OF THE CYCLOTRON FREQUENCY OF FREE ELECTRONS IN A QUADRUPOLE FIELD. Graeff, G.; Klempt, E. (Univ., Bonn). Z. Naturforsch., 22A: 1960-2(Dec. 1967). (In German).

Electrons were stored for several minutes in a homogeneous magnetic field and an electrical quadrupole field $V = (U_0/R^2) \cdot (x^2 + y^2 - 2z^2)$. The solution of the Schroedinger equation can be reduced to the problem of three harmonic oscillators. The frequencies of these oscillators were measured experimentally and thus the cyclotron frequency of free electrons was determined. (auth)

18055 ACTIVATION HALF-LIVES IN ACCELERATORS. Freytag, E. (Deutsches Elektronen-Synchrotron, Hamburg). Health Phys., 14: 267-9(Mar. 1968).

Good agreement was found between ionization chamber dose-rate measurements in the DESY accelerator tunnel, after shutdown for times up to 5×10^4 min, and the Sullivan–Overton formula, despite certain assumptions. A dose-rate half-life is defined which does not involve certain parameters appearing in the formula, but involves variables for accelerator operating time and time since shutdown. This half-life, however, changes only by a factor of 5 for operating times differing by three orders of magnitude. (UK)

18056 POSITRON STACKING AND OBTAINING OF ELECTRON–POSITRON BEAMS IN SYNCHROTRON. Ado, Yu. M.; Belovintsev, K. A.; Bessonov, E. G.; Cherenkov, P. A.; Shirchenko, V. S. At. Energ. (USSR), 23: 3-6(July 1967). (In Russian).

Experimental data are given on the accumulation of electron–positron beams in a 280 MeV synchrotron with a 7.5 and 14 MeV microtron source for electrons and positrons, respectively. The electron beams from the microtrons were transported to the diffuser and converter distributed at the edge of the synchrotron working area. As a result $\sim 10^4$ positrons and $\sim 10^8$ electrons were accumulated at $\sim 10^{11}$ electrons in each microtron pulse. The problems related to the injection with particle lifetime in the storage element, with alternating magnetic fields, and with the conversion of accumulated particles into constant energy are discussed. (tr-auth)

18057 STABILIZATION AND MEASUREMENT OF THE CURRENT OF A PULSED-BEAM ELECTRON LINEAR ACCELERATOR. Kozlov, Yu. D.; Matyukov, M. D.; Sekachev, V. I. Prib. Tekh. Eksp., No. 4, 201-2(July-Aug. 1967). (In Russian).

The induction register of the electron current was a ferrite ring consisting of two halves united in one piece without a gap by means of teflon washers. The external core diameter was 64 mm, and the internal diameter was 51.5 mm. The thickness was 30 mm. A total of 540 turns of wire were wound on the core in a single layer. One end of the wire was attached to the accelerator body directly in the vacuum chamber, and the other end was brought out to a special contact. The unit was calibrated to measure beam current from 2 to 250 μA at a pulse duration of $\tau = 2.5$ μsec for 1.4 MeV electrons. The sensitivity was at least 0.2 mv/μA, and the accuracy of the current measurement was ±1.5%. The signal from the coil depended only on the beam current, and did not depend on a possible displacement with respect to the center of the ferrite ring. The coil signal was amplified and used to stabilize the beam current to 5% of its average value with a control time of 1 to 2 sec. (TTT)

18058 DARESBURY NUCLEAR PHYSICS LABORATORY. Electron. Power, 13: 295-7(Aug. 1967).

It is stated that the UK Science Research Council's Daresbury Nuclear Physics Laboratory built around the 4-GeV electron synchrotron, NINA (National Institute Northern Accelerator), could pave the way for discoveries that may have far-reaching effects on the future of science and technology. A general review is given of the build-up of the synchrotron, the laboratory, and subsidiary apparatus. Also mentioned is the work in progress, together with an outline of possible future applications. (UK)

18059 DOUBLING THE RADIATION OUTPUT OF A BETATRON BY PULSE OPERATION OF THE MAGNET. Sipek, L. (Inst. of Plasma Physics, Prague). Nucl. Instrum. Methods, 59: 353-4(Feb. 1968).

A circuit with four controlled switches for twofold increase of the betatron intensity is described. The circuit doubles the number of accelerating cycles in comparison to ac operation; the betatron magnet losses remain the same. (auth)

18060 ON THE BEAM ENERGY SPREAD OF A PULSED VAN DE GRAAFF ACCELERATOR. Beckman, L.; Jansson, R. (Research Inst. of National Defence, Stockholm). Nucl. Instrum. Methods, 59: 355-6(Feb. 1968).

The beam energy spread of the 2.5 MeV Van de Graaff accelerator at the Research Institute of National Defence has been measured by investigating the gamma-ray yield from the reaction $^{13}C(p,\gamma)^{14}N$ at the 1.75 MeV resonance. The observed values of energy spread (fwhm) were 0.14% for continuous beam, 0.15% for internally pulsed beam (10 ns pulses) and 0.34% for a pulsed and bunched beam (1 ns pulses). (auth)

18061 IMPROVED ENERGY RESOLUTION OF VAN DE GRAAFF ACCELERATORS. Bloch, R.; Pixley, R. E.; Reichart, W.; Zamboni, F. (Univ., Zurich). Nucl. Instrum. Methods, 59: 325-8(Feb. 1968).

It has been found that increasing the gain band width of the voltage control circuit of a Van de Graaff accelerator greatly improves the obtainable energy resolution. The resulting resolution measured at 1 MeV proton energy is 60 eV fwhm. The circuitry and measuring techniques are described. (auth)

18062 DISCHARGE IN GAS DESORBED FROM THE ANODE IN A CROSSED FIELDS ANNULAR ION SOURCE. Becherer, R.; Bariaud, A.; Prevot, F. (CEA, Fontenay-aux-Roses, France). Nucl. Instrum. Methods, 59: 329-32(Feb. 1968).

The operation of an annular ion source with crossed electric and magnetic fields, in which the anode is made of titanium, is compared with the operation of the same source with a copper anode. When the titanium anode is loaded with hydrogen, the discharge can develop in the gas coming from the titanium. The gas concentration is maximum in the discharge region near the anode and the gas efficiency of the source is increased by a factor of two. (auth)

18063 STUDY OF BEAM EXTRACTION AND EMITTANCE FROM A DUOPLASMATRON ION SOURCE. Gautherin, G. (CNRS, Orsay, France). Nucl. Instrum. Methods, 59: 261-71 (Feb. 1968). (In French).

The research of high intensity beams and their good optical quality leads to the study of the detailed mechanism of ion beam extraction. Particularly, high voltage is shown not to influence the intensity of the output beam, but only its optical properties. The effects of space charge on emittance measurements are examined. Two methods are proposed in order to reduce losses on the walls in the expansion cup. Ionic energies, post-ionization, azimuthal and longitudinal motions appear as non negligible. At last, brightness values (which in our source reach or exceed 10^{11} A/m^2 · rad^2) can be related to the parameters of the plasma, taking into account the non-negligible initial ionic velocities. (auth)

18064 SIMPLE TIME-TO-PULSE-HEIGHT CONVERTER FOR USE WITH A PULSED ACCELERATOR. Johnson, F. A. (Defence Chemical, Biological, and Radiation Establishment, Ottawa). Nucl. Instrum. Methods, 59: 237-44(Feb. 1968).

A TPHC is described which was designed for use with a post-acceleration deflection system operating at 3.525 MHz. The converter is started by a sharply differentiated pulse from the anode of a PM, and is stopped by a pulse derived from the sinewave induced in a pick-up loop coupled to the tuned transformer of the deflector. A deadtime of a few μsec is provided after every conversion. The electronic resolution was measured to be 60 ps, determined with the aid of a circuit which provides a fast pulse at a low rate, synchronized with the input sine wave. The differential non-linearity was measured as ±2% over 90% of the range; the PHA which was employed for this measurement had a manufacturer's specified differential linearity of 2%. The integral linearity of the TPHC was determined by means of a new oscillator method developed in this laboratory. Start and stop pulses are derived from independent crystal-controlled sources, and the integral linearity curve can be determined without reference to calibrated delay lines. The time reference for the calibration is the period of the deflector oscillator. A comparison of the integral linearity so determined is made with that obtained using delay cables which had been calibrated by various methods. The integral linearity over the major part of the range is at least as good as that (0.4%) of the PHA which was employed. (auth)

18065 NEW SOURCE OF HIGHLY STRIPPED HEAVY IONS. Daugherty, J. D.; Grodzins, L.; Janes, G. S.; Levy, R. H. (Avco Everett Research Lab., Everett, Mass.). Phys. Rev. Lett., 20: 369-71(Feb. 19, 1968). (NYO-3863-3).

A device is described which operates on the principles of the heavy ion plasma accelerator (HIPAC) and can be used as a source of very highly stripped ions. This device creates a topological closed potential well by virtue of the space charge of a cloud of electrons contained in a toroidal vacuum vessel. The electrons themselves are contained by an azimuthal magnetic field. Since the kinetic energy of the electrons in the HIPAC is ~10 keV, ions trapped by the potential well will become highly stripped. The deep potential well due to the space charge (~20 MV) then accelerates the stripped ions to energies of nuclear interest. It is also suggested that the stripped ion created in a HIPAC device be extracted by subsequent acceleration in any type of accelerator, conventional or unconventional. (B.G.D.)

18066 PROGRAMMA FIZICHESKIKH EKSPERIMENTOR NA KIBERNETICHISKOI USKORITELE PROTONOV NA ENERGIYU. (Program of the Physical Experiments on a 1000-GeV Cybernetic Proton Accelerator). Dolgosheina, B. A. Radioteknicheskii Institut, Moscow, Akademiya Nauk SSSR, Moscow, 1967. 302p. (In Russian).

This book describes a program of physical experiments for the 1,000 GeV proton accelerator now in the process of design. Since this is the largest accelerator to be built, the scientific and technical problems involved are of tremendous complexity and magnitude. This book is the result of investigations made by the Moscow Engineering-Physics Institute from 1964 to 1966 under the general direction of V. V. Frolov, in accordance with the assignment of the Radio Engineering Institute of the Academy of Sciences USSR. The Physics Institute imeni Lebedev, the Atomic Energy Institute imeni Khurchatov and the Consolidated Nuclear Research Institute also participated in this work. The book consists of an introduction which gives in general terms the modern status of the theoretical problems of the physics of elementary particles, and eleven chapters. Chapters I–VIII are dedicated to the development of the arrangements for various experiments. In Chapter IX, the problem of the protection of the individual parts of the accelerator from radiation is discussed. Chapter X covers the program for physical experiments on an 18 GeV proton synchrotron-injector (booster). Chapter XI considers technical questions related to the design of a separating channel. This book does not claim to be entirely comprehensive, and the writers expect that many new problems will arise not only in the process of building the accelerator, but especially after the first results of the experiments are obtained. The expressed aim is to make significant contribution in the study of the structure of matter, space and time. (JPRS)

18067 KIBERNETICHESKII USKORITEL PROTONOV NA ENERGIYU 1000 GeV. (1000-GeV Cybernetic Proton Accelerator). Vasilev, A. A. (ed.). Radiotekhnicheskii Institut, Akademiya Nauk SSSR, Moscow, 1967. 392p. (In Russian).

The systems and results of the preliminary design of the basic (large), 1,000-GeV annular proton accelerator, intermediate annular 196-GeV accelerator (booster), and linear 800-MeV accelerator-injector are described. The study, which established the feasibility of the 1,000-GeV cybernetic proton accelerator on the basis of the existing elements and tested designs of elements, was prepared by a team of specialists of the Radio-Engineering Institute of the AS USSR. The work started in 1960. In order to increase the mean intensity up to $\sim 10^{13}$ protons per second, the particles are accumulated in a large ring serviced by a linear accelerator and a booster, both working at a repetition frequency of about 20 Hz. Specially designed automatic control devices will prevent the shifts of orbits outside the region of the magnetic field. Digital computers will be used for the overall control and adjustment during various possible operating conditions. (JPRS)

18068 METHOD FOR COOLING THE WALL OF AN ACCELERATING CAVITY-BODY FOR A LINEAR ION ACCELERATOR. Otsuki, Toshihiro (to Mitsubishi Electric Mfg. Co.). Japanese Patent 1967-7755. Mar. 29, 1967. Filed Apr. 28, 1965.

By the method proposed, the temperature difference in the wall of an accelerating cavity-body can be easily controlled within a desired temperature range, and futhermore a uniform temperature distribution, along the axis of the cavity body, can be obtained. On the outside surface of the cavity-body wall are installed a plurality of axial (and parallel) cooling-water conduits. Cooling water is run through the conduits in such a manner that the water flow in one conduit is in the opposite direction to that in the next conduit. (NSA of Japan)

18069 HIGH FREQUENCY ION SOURCE. Akatsu, Yoshi (to Hitachi Ltd.). Japanese Patent 1967-7440. Mar. 25, 1967. Filed Jan. 5, 1965.

By the method proposed, the effect of a metal film, formed on the inner surface of the discharge tube, is eliminated, thus lengthening the life of the high-frequency ion source. (1) It consists of a discharge tube, the anode installed at the top of the discharge tube; the ion exit located at the bottom of the discharge tube; and a high frequency power supply element installed within the discharge tube. (2) In addition to the above: the high-frequency power supply element is in a joint state with the anode. (3) In addition to (1): the high-frequency power supply element is in a joint state with the ion exit. (NSA of Japan)

18070 IRRADIATION WINDOW FOR AN ELECTRON ACCELERATOR. Aihara, Ryuzo (to Sumitomo Electric Industries, Ltd.). Japanese Patent 1967-9519. May 23, 1967. Filed Dec. 30, 1963.

By the method proposed, when objects are irradiated successively, the electron current can be measured and also the number of objects irradiated can be checked. Electrodes are installed just in front of the window, between the window and the object. And the back-scattered electrons from the object are detected by this means. (NSA of Japan)

18071 DEVICE FOR SUPPLYING POWER TO THE HIGH POTENTIAL POSITION OF A CHARGED PARTICLE ACCELERATOR ETC. Arakawa, Kazuo (to Matsushita Electric Industries Co., Ltd.). Japanese Patent 1967-7759. Mar. 29, 1967. Filed Jan. 15, 1965.

A compact power-supply device is proposed for the ion source (or electron gun) of a charged-particle accelerator; no limitation is placed to the distance between the dynamo and the means for running the dynamo. A dynamo and an oil-pressure motor (or an air turbine) connected to the dynamo mechanically are installed at the high-potential position of a charged-particle accelerator. The motor (or turbine) is connected to an oil-pressure (or gas-pressure) generator at the earth potential, through an insulated conduit. The dynamo is run by the oil-pressure motor (or air turbine). (NSA of Japan)

18072 METHOD FOR FABRICATING A DRIFT TUBE FOR A LINEAR ION ACCELERATOR. Nagai, Akio (to Mitsubishi Electric Mfg. Co.). Japanese Patent 1967-7756. Mar. 29, 1967. Filed Apr. 28, 1965.

The advantages of the method proposed are a minimization of the use of oxygen-free copper, increase of the space for a focusing tetrode-electromagnet or coil, and the possibility of its mass production. It consists of the step where the drift-tube body is made of a material other than copper, whose strength is larger than copper; and the step where the drift-tube body is clad on the outside with copper or other metal having a better conductivity than copper. (NSA of Japan)

18073 ION SOURCE. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1967-9518. May 23, 1967. Filed Jan. 23, 1965.

In the ion source proposed, which is used for a plasmatron etc., its power sources are simplified. As is usual, it consists of a filament, an anode, an intermediate electrode, the coils around the intermediate electrode, and so on. The filament and the coils are connected in series. (NSA of Japan)

18074 CHARGED PARTICLE ACCELERATING DEVICE. Adachi, Takeshi (to Tokyo Shibarua Electric Co., Ltd.). Japanese Patent 1967-9520. May 23, 1967. Filed Mar. 19, 1965.

The charged-particle accelerating device proposed can take both the horizontal and the vertical position by a simple means. In the horizontal position the horizontal support (base) is laid on the floor, and the vertical support stands from a point on the horizontal support. From the upper part of this vertical support protrudes to the right (for example) an accelerating tube, an accelerating-voltage source, etc., in series; on the other side of this vertical support are the extension of the accelerating tube, a target, and an evacuation device. Then, in the vertical position the former posture in the horizontal position is turned round appropriately 90°, now the formerly horizontal support becoming vertical and the formerly vertical support horizontal; a leg comes down from the end of the now horizontal support, to support it against the floor. (NSA of Japan)

18075 METHOD AND DEVICE FOR ADJUSTING THE ACCURACIES OF A CORRUGATED SLOW WAVE CIRCUIT. Sawada, Ryoka (to Hitachi Ltd.). Japanese Patent 1966-19931. Nov. 18, 1966. Filed Apr. 14, 1962.

In devices with a corrugated slow-wave circuit, e.g., the accelerating tube of a linear accelerator, if the accuracy in working its respective members was low, the resonance frequencies of the cavities, constituting the slow wave circuit, become deviated from the design values, thereby making the electron acceleration inefficient. By the proposed method and device, the slow wave circuit, of high accuracy, can be constructed with not very accurately worked members, and furthermore its adjustment is extremely simple for a high efficiency of the accelerating tube. (1) In the adjusting method: a plurality of resonance cavity members are combined to the adjusting standard cavity members constructed with high accuracy, in order to give the cavities for adjusting purposes. A correction is made of the shape of the cavity members to be adjusted, so as to make the resonance frequencies of the adjusting cavities take the preset values. (2) In the adjusting device: there are provided the adjusting casings, possessing the spaces where the adjusting cavities, provided by the said combination, are each installed; a device for supplying a high-frequency power to the adjusting casings; and a device for measuring a resonance curve of the adjusting cavities. (NSA of Japan)

18076 DRIFT TUBE FOR A LINEAR ION ACCELERATOR. Ueda, Kazuhiro (to Mitsubishi Electric Mfg. Co.). Japanese Patent 1967-7757. Mar. 29, 1967. Filed Apr. 28, 1965.

The advantages of the method proposed are the possibility of continuous detection of the value of charged-particle current through the accelerating cavity bodies; and the installation of the focusing-electrode electromagnets (or focusing coils) and the ion-current value detectors, without using much space in the accelerating cavity bodies. The drift tube consists of the drift-tube body, having a central hole through which the charged particles pass, and an empty space; a device, installed in the space, for focusing the charged particles; and a device, also installed in the same space, for detecting the value of charged-particle current. (NSA of Japan)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 16920, 16940, 16948, 18046, and 18557.

18077 (EIR-126) SOS-1: A PROGRAM FOR CALCULATING THE FLUX IN HETEROGENEOUS SYSTEMS. Burnand, G. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Aug. 1967. 25p. Dep.

The computer program SOS-1 for calculating the flux in heterogeneous critical or subcritical systems is described. The moderator flux is obtained from diffusion theory; three energy groups are used. The flux is expanded into a Fourier series around the surface of each element, and boundary conditions at channel surfaces are specified in terms of absorption and production coefficients. Extrapolated radii of the system are allowed to vary from group to group. (D.C.W.)

18078 (STI/PUB-140(Vol.1)) NUCLEAR DATA FOR REACTORS. Proceedings Series. Proceedings of a Conference held in Paris, 17–21 October 1966. (International Atomic Energy Agency, Vienna (Austria)). 1967. 589p. (CONF-661014-(Vol. 1)). IAEA: $12.00; Austrian Schillings 310,-; £ 4.4.8; F Fr 58,80; DM 48,-.

Separate abstracts were prepared for 23 of the 67 papers included. Thirteen papers are included in abstract form only. The other 31 papers have previously appeared in NSA and may be located by referring to CONF-661014 in the report number index. (D.C.W.)

For abstracts of individual papers see: 18099–18105, 18146, 18147, 18192–18195, 18281–18289, and 18347.

18079 (STI/PUB-140(Vol.2)) NUCLEAR DATA FOR REACTORS. Proceedings Series. Proceedings of a Conference held in Paris, 17–21 October 1966. (International Atomic Energy Agency, Vienna (Austria)). 1967. 446p. (CONF-661014-(Vol. 2)). IAEA: $9.00; Austrian Schillings 233,-; £ 3.3.6; F Fr 44,10; DM 36,-.

Separate abstracts were prepared for 16 of the 39 papers included. Seven papers are included in abstract form only. The other 16 papers have previously appeared in NSA and may be located by referring to CONF-661014 in the report number index. (D.C.W.)

For abstracts of individual papers see: 18106–18109, 18290–18299, 18348, and 18349

18080 DISPERSION LAW OF A NEUTRON WAVE IN A FINITE SYSTEM. Williams, M. M. R. (London Univ.). J. Nucl. Energy, 22: 153-61(Mar. 1968).

An integral equation describing the propagation of a neutron wave along the axis of an infinite prism is derived. The homogeneous part of this equation constitutes a dispersion relation, for the wavenumber as a function of frequency. By means of the integral equation it is proved that for a neutron wave, with wavenumber Λ and frequency ω, propagating along the axis of an infinite prism, there exists a minimum transverse dimension of the prism below which a dispersion law $\Lambda(\omega)$ can no longer be defined. A practical working expression was obtained for the maximum transverse buckling which allows the existence of a discrete wave and this was compared with an experiment performed in graphite. (auth) (UK)

18081 SOME REMARKS ABOUT INELASTIC SCATTERING CROSS SECTIONS AS USED FOR REACTOR CALCULATIONS. Schmidt, F.; Buehler, F. (Univ., Stuttgart). J. Nucl. Energy, 22: 187-9(Mar. 1968).

The calculation of inelastic scattering cross sections for fast neutrons by the simple Hauser–Feshbach theory with good parameter fitting is shown to give as good results as more detailed theory for ^{238}U. (UK)

18082 SCATTERING OF SLOW NEUTRONS BY WATER MOLECULES. Samosvat, G. S.; Sayasov, Yu. S.; Chuburkov, V. T. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 54: 29-36(Jan. 1968). (In Russian).

The doubly differential cross section for scattering of neutrons on molecules is measured by a method based on fixing the final scattered neutron energy by means of a resonance detector (neutron resonance at 4.91 eV in gold was used). The results of the scattering measurements in water confirm the model in which a chemically bound nucleus scattering eV neutrons behaves as a quasifree nucleus. (auth)

18083 CALIBRATIONS OF THE THERMAL NEUTRON FLUX DENSITY STANDARDS UNDER THE INTERNATIONAL INTERCOMPARISON PROGRAM. Inoue, Yajiro; Yura, Osamu; Michikawa, Taichi; Yamashita, Mikio (Electrotechnical Lab., Tokyo). Denki Shikensho Iho (Japan), 31: 972-84(1967).

As a part of the world-wide program of the intercomparison of the thermal neutron flux density standards, seven particular standards of different countries were calibrated in terms of the neutron capture cross section of Au by following the identical procedures. The procedures and method of calibration, precision determination of the disintegration rate of the induced activity by means of the $4\pi\beta-\gamma$ coincidence method and the final results are described. The overall accuracy attained of the final results ranges from about 1 to 1.5% in the sum of random and systematic errors, depending upon the Cd ratios of the particular neutron fluxes. It is shown that the major part of the error in the final results arises from the uncertainties of the associated parameters, such as the Cd correction factor, the effective capture cross section of Au and a correction factor for flux depression, self-shielding and edge effect. (auth)

18084 PARAMAGNETIC SCATTERING OF NEUTRONS FROM A HEISENBERG SYSTEM. Kwon, T. H.; Gersch, H. A. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 167: 458-60 (Mar. 10, 1968).

The neutron paramagnetic scattering function for a Heisenberg system is evaluated in the high-temperature limit and in the cluster model. The numerical results for several different cluster configurations are presented for various values of scattering vector. The scattering function for a simple cubic lattice with spin $\frac{1}{2}$ is compared with the frequency distribution functions derived from the method of moments by de Gennes and by Collins and Marshall. (auth)

18085 TECHNOLOGY OF THE D–T NEUTRON TUBES. Bobrowski, Czeslaw; Chrusciel, Edward (Instytut Techniki Jadrowej, Krakow). Przegl. Elektron., 7: 487-91(Oct. 1966). (In Polish).

The problems encountered in the design and fabrication of d-T tubes are discussed, and the equipment and techniques that are used in the fabrication of such tubes are briefly described. (D.C.W.)

18086 INELASTIC SCATTERING OF COLD NEUTRONS BY METHANE AND AMMONIA. Webb, F. J. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 92: 912-20(Dec. 1967).

The inelastic scattering of cold neutrons by gaseous methane and ammonia was investigated to test the accuracy of the theories of neutron scattering by molecules. The experimental results at small scattering angles, corresponding to small neutron momentum transfers, show separate peaks due to translational and rotational motions of the molecules, demonstrating the shortcomings of the Krieger–Nelkin theory (Phys. Rev., 106: 290-5(1957)). Agreement with Griffing's theory (Phys. Rev., 124: 1489-93(1961)), assuming discrete rotational levels, is good at high scattering angles, but at the lowest angles there is a small discrepancy between the theoretical and measured heights of the translational and rotational peaks. (auth) (UK)

18087 SUGGESTED PROCEDURES FOR UTILIZING MUFT RESONANCE PARAMETERS TO INCLUDE DOPPLER BROADENING. Goldman, David T. (National Bureau of Standards, Washington, D. C.). Nucl. Sci. Eng., 31: 346-9(1968).

A technique is proposed for including some of the effect of Doppler broadening by replacing the unbroadened peak cross section in the cross-section library by that calculated at a temperature one-half that of the scattering material. (D.C.W.)

18088 INELASTIC NEUTRON SCATTERING IN FERROMAGNETIC METALS. Thompson, E. D. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev. Lett., 19: 635-6 (Sept. 11, 1967). (ORNL-P-3349).

The relative magnetic inelastic neutron scattering from spin waves and the continuum spin-flip band in a ferromagnetic metal is shown to depend upon the wave vector $\vec{q}$. In particular, the scattering from the continuum band vanishes as $q \rightarrow 0$, and the scattering from the spin waves vanishes as $q \rightarrow q_{max}$, the cutoff vector for spin waves. (auth)

18089 ANALYTICAL METHOD FOR CALCULATING OF SMALL DIMENSION TWO-REGION HETEROGENEOUS REACTORS. Nosov, V. I. At. Energ. (USSR), 23: 25-8(July 1967). (In Russian).

A multigroup diffusion approximation method was used in calculation of a cylindrical finite dimension reactor with arbitrary assembly distribution along each zone. The solution was obtained in a matrix form taking into account the azimuthal symmetry of the neutron flux along the reactor and the assembly. The boundary conditions on the surface of assemblies are written out in a matrix. The data were programmed on the EBM M-20 computer. (tr-auth)

18090 INFLUENCE OF THE ANISOTROPIC SCATTERING ON THE CRITICAL PARAMETERS IN THE ONE-DIMENSIONAL GEOMETRY. Stankiewicz, Roman (Instytut Badan Jadrowych, Swierk, Poland). Nukleonika, 12: 1007-26(Nov. 1967). (In Polish).

The critical slab problem is solved for the case of anisotropic scattering using the eigenfunction expansion method. The resulting singular integral equations are further reduced to Fredholm equations in two different ways. Accordingly, two approximate methods are applied to solve the Fredholm equations. The numerical results are given. (auth)

18091 NUMERICAL RESULTS FOR THE EIGENVALUES AND EIGENFUNCTIONS OF THE NEUTRON TRANSPORT EQUATION FOR A SLAB. Kerner, I. O.; Kiesewetter, H.; von Weber, S. (Univ., Rostock, Ger.). Kernenergie, 10: 299-306(Oct. 1967). (In German).

On the basis of formulas given in a previous paper, the first ten eigenvalues and eigenfunctions of the stationary monoenergetic neutron transport equation with isotropic scattering for the slab were calculated. For a slab of optical thickness 2δ values within the interval $2\delta = 20$ to $2\delta = 0.02$ were considered. The convergence factor of the Neumann series increases up to 0.7 for the extremely thin slab of thickness $2\delta = 0.02$. (auth)

18092 ALBEDO AND MILNE'S PROBLEM FOR THERMAL NEUTRONS. Pahor, S. (Univ. of Ljubljana, Yugoslavia). Nucl. Sci. Eng., 31: 110-16(1968).

The method for solving time-independent one-speed half-space transport problems, which was explained in earlier papers, is applied to find the emerging distributions for the albedo and Milne problems for thermal neutrons with the isotopic degenerate kernel. By using the principle of invariance and the reciprocity theorem, these distributions are expressed in terms of the H-matrix. This matrix is a generalization of the one-speed Ambarzumian–Chandrasekhar H-function and satisfies a nonlinear integral equation. The conditions, which uniquely determine the physical solution of this equation, are derived. At the end, the possibilities for calculating the H-matrix by iteration are discussed. 21 references. (auth)

18093 S_∞ NEUTRON TRANSPORT THEORY IN PLANE GEOMETRY. Mennig, J.; Marti, J. T. (Eidgenossisches Institut fuer Reaktorforschung, Wurenlingen, Switzerland). Nucl. Sci. Eng., 31: 365-8(1968).

A semi-analytical method for solving the monoenergetic transport equation with isotropic scattering in plane geometry is developed, in which the slab system is subdivided into a number of discrete space points in x, while the angular variable is treated analytically. This is equivalent to taking N to ∞ in S_N theory and avoids the numerical instabilities inherent in the limiting process. General boundary conditions are introduced allowing finite multilayer slabs, cells, and shielding problems with specified incident angular distribution of neutrons to be handled by the same formalism. Analytical expressions are derived for the angular distributions, and fluxes are obtained by solving a matrix problem, where the matrix elements are integrals over rational functions of the angular variable. Computing times are comparable to low-order S_N calculations. (auth)

18094 NEUTRON-WAVE PROPAGATION THROUGH A CRYSTALLINE MODERATOR. I. BERYLLIUM. Ahmed, Feroz; Grover, P. S.; Kothari, L. S. (Univ. of Delhi). Nucl. Sci. Eng., 31: 484-91(1968).

The propagation of neutron waves through crystalline moderator beryllium was studied. The two simultaneous integral equations in the real and imaginary part of the flux are reduced to a single homogeneous integral equation in an extended energy interval, and this is solved by an iterative procedure to determine the fundamental-mode eigenvalues and eigenfunctions for various angular frequencies of the source. It is shown that for frequencies exceeding a certain critical frequency ω^*, no discrete mode exists. Various parameters were deduced including D_0, the diffusion constant, and C, the diffusion cooling constant. These values are compared with the values obtained from pulsed-neutron experiments. (auth)

18095 INCREASES IN NEUTRON YIELDS OF PLUTONIUM–BERYLLIUM (α,n) SOURCES. Anderson, M. Edward (Monsanto Research Corp., Miamisburg, Ohio). Contract AT(33-1)–Gen-53. Nucl. Appl., 4: 142-7(Mar. 1968). (MLM-1447J).

The neutron yields of plutonium–beryllium (α,n) sources, made of nominal ^{239}Pu, are increasing due to the buildup of ^{241}Am, an alpha emitter, from the beta-decay of ^{241}Pu which is present in these sources. Measured increases in yields are compared with predicted increases based on the isotopic composition of the plutonium used in these sources. In cases where the isotopic composition was not previously known, the composition was deduced from calorimetric measurements. Sources were found to have initial rates of increase of up to 2% per year. In all cases except one the measured rate of increase was in agreement with the predicted rate. (auth)

18096 ADJUSTING ABSORPTION CROSS SECTIONS IN TRANSPORT CALCULATIONS TO ACHIEVE SPECIFIED REGION CAPTURE INTEGRALS. Rampolla, Donald S. (Westinghouse Electric Corp., West Mifflin, Pa.). Contract AT(11-1)-Gen-14. Nucl. Sci. Eng., 31: 396-414(1968). (WAPD-T-1978).

In the design of nuclear reactors it is frequently necessary to adjust the parameters appearing in the equations describing neutron transport, e.g., the macroscopic absorption cross section in the diffusion equation, in order to force region reaction rates to agree with results of more exact calculations or experiment. Given a multiregion cell problem with a specified absorption rate in each region it is proved that there exists, for any neutron transport equation that has a solution that is everywhere positive, a non-unique set of region absorption cross sections which yield the specified absorption rates; however, if the cross section is fixed in one region, the set is, in a specially defined sense, unique. Two systematic iterative methods for obtaining such sets of region cross sections are presented; one of these methods has been incorporated into a computer program. (auth)

18097 PULSE PROPAGATION EXPERIMENTS OF THERMAL NEUTRONS IN GRAPHITE. Takahashi, Akito; Sumita, Kenji (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 7-17 (Jan. 1968).

Pulse propagation experiments of thermal neutrons were carried out in a graphite system to investigate the diffusion and the thermalization processes of neutrons in graphite. The principle of the thermal pulse source used was based on the distinct difference in the slowing down and the thermalization times between paraffin and graphite. From the Fourier-transformed data of the measured propagating thermal pulses were derived the inverse attenuation length and the phase lag per unit length as functions of frequency. Peaks and caves distinctly observed in the gain and the phase lag curves at various distances from the source surface in the range of frequency above 2,000 Rad/sec were attributed to the existence of a continuum eigenvalue region, due to cold neutron penetration into the frequency-dependent attenuation. The diffusion and diffusion cooling coefficients were derived into the range below this frequency. The results (reduced to 20°C, 1.6 g/cm^3 density) are: $D_0 = 2.16 \pm 0.02 \times 10^5$ cm$^2 \cdot$ sec^{-1} and $C_0 = 2.8 \pm 0.3 \times 10^6$ cm$^4 \cdot$ sec^{-1}. The results of dfe away experiment using the same graphite under critical buckling are: $D_0 = 2.21 \pm 0.08 \times 10^5$ cm$^2 \cdot$ sec^{-1} and $C_0 = 2.6 \pm 1.2 \times 10^6$ cm$^4 \cdot$ sec^{-1}. This agreement is obtained by rejecting the data in the continuum region, and the present values are closer to the more recent theoretical values than derived from experiments by other authors. (auth)

18098 NEUTRON SCATTERING IN NORMAL AND DEUTERATED POLYETHYLENE. Lynch, J. E., Jr.; Summerfield, G. C.; Feldkamp, L. A.; King, J. S. (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 48: 912-17(Jan. 15, 1968).

The one- and two-phonon amplitude-weighted directional frequency functions are calculated for normal and deuterated crystalline polyethylene. These results are compared to previously measured frequency spectra for stretch-oriented normal polyethylene and to new measurements on deuterated polyethylene. In addition, the Debye–Waller factors are calculated for oriented polyethylene and are compared with elastic-scattering data. (auth)

18099 COMMUNICATION BETWEEN THE DATA EVALUATORS AND COMPILERS AND THE DATA USERS. Usachev, L. N. (Inst. of Physics and Energetics, Obninsk, USSR). pp 3-10 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014–(Vol.1).

The widening gulf in communication between the data evaluators and compilers and the scientists using the data is emphasized. Present standards in relation to needs, comparison of the cross sections of fissile nuclides, and neutron data evaluation are mentioned; and a call for better international co-operation in the field of nuclear data is suggested. (R.V.J.)

18100 NUCLEAR DATA REQUIREMENTS FOR THERMAL REACTOR DESIGN AND OPERATION. Kinchin, G. H. (Atomic Energy Establishment, Winfrith, Eng.). pp 13-26 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

The accuracy with which nuclear data must be known for prediction of the properties of thermal reactors is discussed. The status of the available data is reviewed in view of the required accuracy. (D.C.W.)

18101 NUCLEAR DATA REQUIREMENTS FOR FAST REACTOR DESIGN AND OPERATION. Smith, R. D. (Atomic Energy Establishment, Winfrith, Eng.). pp 27-36 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

Calculations of the neutron physics behaviour of a reactor requires accurate nuclear data which must be supplied by nuclear physics measurements supplemented by integral measurements on zero-power reactors. The nuclear physics parameters of a power reactor are needed for three main purposes: design, safety studies, and operations. The accuracy required increases as the reactor progresses from the design-concept stage through detailed design to construction and operation. The main parameters needed for fast reactors are discussed together with an indication of the accuracy required. The methods by which the accuracy of the data needed to meet these requirements can be deduced are then considered It is shown that precise independent definitions of the required accuracy for all cross-sections cannot be obtained but that the published data request list forms a good working guide for data measurers. Some of the more important data requests are highlighted, and it is pointed out that a limit to the accuracy needed is set by limits in our knowledge of the composition of actual reactors. (auth)

18102 CROSS-SECTION REQUIREMENTS FOR NEUTRON SHIELDING. Goldstein, H. (Columbia Univ., New York). pp 39-48 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

The requirements for neutron cross sections that are to be used in shielding calculations are discussed. The differences in requirements for reactor core calculations and shielding calculations are considered. (D.C.W.)

18103 EQUIPMENT AND PROGRAMS FOR ACQUISITION AND PROCESSING OF TIME-OF-FLIGHT DATA. Ribon, P.; Cauvin, B.; Derrien, H.; Michaudon, A.; Sanche, M. (CEN, Saclay, France). pp 107-18 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

The equipment and programs used for carrying out and interpreting time-of-flight experiments with the Saclay linear accelerator are described. (auth)

18104 PROCESSING AND ANALYSIS OF NEUTRON TRANSMISSION DATA AND CONSIDERATIONS OF THE ACCURACY. Fuketa, T.; Asami, A.; Ohkubo, M.; Nakajima, Y.; Kawarasaki, Y.; Takekoshi, H. (Japan Atomic Energy Research Inst., Tokyo). pp 147-55 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

The main features of the computer programs which are being used in processing and analyzing the neutron transmission data from a time-of-flight spectrometer are described, and the related accuracies are discussed. In these programs, the background is formulated to a channel-dependent expression by making least-squares fitting to the raw data of the background, and the statistical error of the transmission is computed at every individual channel. Some modification of the area-analysis program which was originally written by S. E. Atta and J. A. Harvey of ORNL is made to expand its functions. That is, in the present program, computations are iterated semi-automatically until the values of Γ and Γ_n satisfy the condition of self-consistency, $\Gamma = \Gamma_n + \Gamma_\gamma$, for an assumed value of Γ_γ and of the g-factor; and, in estimating the error of the $g\Gamma_n$-value, the statistical error of the transmission at individual channels and the error of the baseline under which the resonance area is defined are taken into account. The accuracy of the final result of $g\Gamma_n$ depends not only on the statistical errors in the transmission data but also on their systematic errors and on the adequacy of the choice of input parameters for the analysis. Some semi-empirical examinations were made on the influences of these errors upon the value of $g\Gamma_n$. A 20% systematic error in the background, whose amount was about 1% of the open-beam counting rate, gave rise to an error of more than 4% in the computed $g\Gamma_n$-value of a resonance chosen for the test. (auth)

18105 NEW METHOD FOR THE MEASUREMENT OF NEUTRON CROSS SECTIONS. Ohanian, M. J.; Perez, R. B.; Uhrig, R. E. (Univ. of Florida, Gainesville). pp 445-52 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

A new technique for the measurement of elastic and inelastic differential neutron cross sections, based on pseudo-random pulsing techniques and statistical correlation methods, is described. The method allows an increase in energy resolution without a reduction in the signal-to-noise ratio because of the inherent 50% duty cycle of the input signal and the ability to reduce the effects of detector and other extraneous noise signals by cross-correlation. The improvement in signal-to-noise ratio and energy resolution that may be achieved over conventional time-of-flight methods is also shown. (auth)

18106 NEUTRON CROSS-SECTION EVALUATIONS: PAST, PRESENT, AND FUTURE. Parker, K. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Goldman, D. T.; Wallin, L. pp 293-307 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

The need and requirements for cross-section evaluations is discussed; and the evaluations that were available on June 1, 1966, are reviewed. (D.C.W.)

18107 THE ACCURACY OF CALCULATIONS OF REACTOR PARAMETERS AS A FUNCTION OF THE ACCURACY OF ELEMENTARY CONSTANTS. Usachev, L. N. (Inst. of Physics and Energetics, Obninsk, USSR); Zaritskii, S. M. pp 321-9 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

An effective procedure for evaluating elementary constants from the viewpoint of their effect on various reactor parameters. This procedure has been developed on the basis of the perturbation theory evolved in a number of studies. This theory contributes linear relations which link variations in elementary constants with the reactor parameter under consideration. The coefficients of these linear relations are calculated by the method set forth in the studies. Storage in the memory of an electronic computer of the matrices of these coefficients for various reactor parameters and for an entire set of fast neutron reactors makes it possible, while operations are going on, to check the effect of different changes in the constants on variations in reactor parameters which are known experimentally. In this way, new data on elementary constants can be evaluated during operation from the point of view of agreement between reactor calculations and experiment. Also, the required accuracy of the elementary constant measurements can be indicated in a simple manner, on the basis of the desired accuracy of the reactor parameter calculations. Tables are given for the above-mentioned perturbation theory coefficients in respect of various parameters measured on a number of ZPR-3 critical assemblies and also for a typical fast power reactor. Examples are given of using these coefficients to solve the problems involved. (auth)

18108 CONTRIBUTIONS OF NEGATIVE ENERGY AND DISTANT RESONANCES IN THE RESOLVED RESONANCE REGION. James, M. F.; Story, J. S. (Atomic Energy Establishment, Winfrith, Eng.). pp 359-68 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

Extensive sets of resonance parameters are becoming available for the neutron cross-sections of many nuclides, from which the partial cross-sections can be computed, over a wide energy range, by using a multilevel resonance formula. To obtain reliable results it is necessary to allow for the effects of negative energy resonances and of unresolved positive energy resonances. The theory of such effects is briefly described. It is possible to calculate numerically the expected contributions to the capture cross section and the effective channel radii from unresolved resonances, assuming that the statistical distributions and mean values of the resonance parameters are known. Approximate formulas for these contributions are given. The standard deviations of the contributions may also be calculated; these are large if the difference between the energy at which the contributions are calculated and the energy at which the unresolved region is assumed to begin is much less than the mean spacing between resonances. All negative-energy resonances could be treated in this statistical manner, but because both the expected contributions and their standard deviations at low energies (e.g., around 0.0253 eV) will then be very large, it is preferable to fix the parameters of the first negative energy resonance, and to treat only the relatively small contributions from the more distant negative energy resonances statistically. Methods are therefore discussed for the estimation of the widths and energy of the first negative-energy resonance. If two spin-states of the compound nucleus may be excited by s-wave neutrons, two such resonances need to be considered. The parameters may be determined quite closely by the values and energy dependence of the low-energy cross sections. However, for some nuclides, particularly if this resonance is small or relatively distant, it is not possible to calculate them so definitely; additional arguments based on the statistical distributions of widths and spacings are then used to select reasonable values for the required parameters. These methods are applied to the low-energy cross sections of the isotopes of nickel. (auth)

18109 INTERNATIONAL COOPERATION IN THE FIELD OF NUCLEAR DATA. Colvin, D. W. (Neutron Data Compilation Centre, Gif-sur-Yvette, France). pp 383-95 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

The various levels of international co-operation in the field of nuclear, particularly the compilation of neutron data, are outlined. American activities, notably CINDA and Sigma Center, are discussed in some detail for historical reasons. (D.C.W.)

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Refer also to abstracts 16864, 16889, 17853, 17972, 17973, 17976, 18125, 18146, 18195, 18313, 18321, 18322, and 18345.

18110 K-MESIC ATOMS: A REVIEW. Uretsky, Jack L. (Argonne National Lab., Ill.). pp 395-408 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

The review of K-mesic atoms included level shift measurement, theory for meson (K^-) interactions with the nucleus, and applications to nuclear physics. (J.F.P.)

18111 INTERACTION BETWEEN ^{3}He AND ^{4}He. Okai, Sueji (Niigata Univ., Japan). Progr. Theor. Phys. (Kyoto), 38: 1413-15(Dec. 1967).

The ^{3}He-^{4}He interaction is investigated within the framework of the resonating group theory using the single-channel approximation. The energy independence of the modes of the scattering function within the contact distance is attributed to the nonlocal potential due to the antisymmetrization among the nucleons involved. It is concluded that for the s, p, d waves the ^{3}He-^{4}He interaction, in the local two-body potential form, contains strongly repulsive short-range parts. (D.C.W.)

18112 NONMESONIC DECAY OF HELIUM HYPERFRAGMENTS. Miller, H. G.; Holland, M. W.; Roalsvig, J. P.; Sorensen, R. G. (State Univ. of New York, Buffalo). Phys. Rev., 167: 922-32 (Mar. 20, 1968).

Approximately 35,000 K^- capture stars in an emulsion stack were examined for hyperfragments. A sample of π^--mesonic and nonmesonic He hyperfragments was selected for the purpose of estimating the nonmesonic-to-π^--mesonic decay ratios for $_{\Lambda}$He and for $_{\Lambda}$He^5. The following values were obtained: $Q(_{\Lambda}\text{He}) = 1.02 \pm 0.15$, $Q(_{\Lambda}\text{He}^5) = 1.21 \pm 0.19$, for the nonmesonic-to-$\pi^-$ mesonic decay ratios of $_{\Lambda}$He and $_{\Lambda}$He^5, respectively. Also, an attempt was made to estimate the ratio of proton stimulation to neutron stimulation for the nonmesonic decays of $_{\Lambda}$He and $_{\Lambda}$He^5, for various cutoff energies of the observed "fast protons." Furthermore, by combining our data with previous results, estimates of the nonmesonic and the total decay rates of $_{\Lambda}$He^4 and $_{\Lambda}$He^5 were obtained. (auth)

18113 MUON CAPTURE IN ^{3}He. Peterson, Earl A. (Stanford Univ., Calif.). Contract AR 49(638)-1389. Phys. Rev., 167: 971-80(Mar. 20, 1968).

The partial capture rate $\mu^- + {}^3\text{He} \rightarrow {}^3\text{H} + \nu$ is calculated, including terms through $\varphi(1/M^2)$ and a phenomenological treatment of the exchange effects. The wave function of the three-nucleon system is largely determined by recent analyses of the electromagnetic form factors. The exchange effects are found to be very important; if they are neglected, two sets of values of F_p consistent with experiment are 0 ± 3 and 35 ± 3, including the exchange effects, $6 \leq F_p/F_A \leq 33$. (auth)

18114 COULOMB ENERGY OF ^{3}He AND LOCAL AND NONLOCAL POTENTIALS IN THE THREE-NUCLEON SYSTEM. Okamoto, K.; Lucas, C. (Univ. of New South Wales, Kensington, Australia). Phys. Lett., 26B: 188-90(Jan. 22, 1968).

Variational calculations of the Coulomb energy of ^{3}He were made using purely central exponential potentials. The effective range parameters for the local potentials were adjusted to be the same as those for the nonlocal potentials. The results indicate that a proper choice of the ^{1}S effective range and a proper account of the hard core in calculations using nonlocal potentials will yield a smaller value for the Coulomb energy than for the binding energy difference, which is in agreement with calculations using local potentials. (D.C.W.)

18115 ENERGY LEVELS OF LIGHT NUCLEI A = 4. Meyerhof, W. E. (CERN, Geneva); Tombrello, T. A. Nucl. Phys., A109: 1-58(1968).

A compilation of energy levels is given for A = 4 nuclei with emphasis on material leading to information about the structure of the A = 4 systems. (auth)

18116 DEUTERON BREAK-UP BY 42 MeV ALPHA PARTICLES. Warner, Robert E. (Oberlin Coll., Ohio); Bercaw, Robert W. Nucl. Phys., A109: 205-17(1968).

Deuteron break-up by 42-MeV alpha particles was studied by measuring absolute cross sections for coincidence detection of the proton and scattered alpha particle. Prominent peaks due to ^{5}He and ^{5}Li final-state interactions as well as broad spectator peaks appear in the energy spectra. Only moderate success was achieved in using single-level R-matrix theory to fit the line shape of the final-state interaction peaks. (auth)

18117 PHASE SHIFTS OF d + α SCATTERING. Thompson, D. R.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Phys. Lett., 26B: 194-6(Jan. 22, 1968).

The resonating-group method with a one-channel approximation is used to study the d + α elastic scattering problem. The result shows that, in the excitation region below 10 MeV, there is no excited odd-parity P level in ^{6}Li which has predominantly a d + α cluster structure. (auth)

18118 PHOTODISINTEGRATION OF THE TRINUCLEON SYSTEM IN A SEPARABLE POTENTIAL MODEL. O'Connell, J. S. (National Bureau of Standards, Washington, D. C.); Prats, F. Phys. Lett., 26B: 197-200(Jan. 22, 1968).

Two- and three-body photodisintegration cross sections of ^{3}H and ^{3}He are calculated. The ground-state wave function used is an exact solution of the three-body Schroedinger equation with separable potentials of the Yamaguchi type. The final states contain the interactions between nucleon pairs. Results are shown both for the Yamaguchi-Sitenko-Kharchenko set and for the Tabakin set of interaction parameters. (auth)

18119 ON THE BEHAVIOR OF THE WAVE FUNCTION OF THE GROUND STATE OF ^{6}Li. Hasegawa, Akira; Nagata, Sinobu (Kyoto Univ.). Prog. Theor. Phys. (Kyoto), 38: 1188-9(1967).

The Schroedinger equation for the relative motion between the alpha and deuteron clusters is derived using the resonating-group method, and the eigenvalue problem is solved. The structure of the wave function of the ground state is clarified on the basis of the dynamics. (D.C.W.)

18120 ON TOTAL CAPTURE RATE OF NEGATIVE MUONS IN ^{4}He. Jain, S. C. (Allahabad Univ., India). Z. Phys., 210: 242-4(1968).

The total capture rate of μ^- in ^{4}He is calculated using a modified Irving wave function whose parameters are obtained from a variational calculation of the binding energy of ^{4}He using a central velocity-dependent potential. (auth)

18121 ELASTIC SCATTERING OF 14 MeV NEUTRONS BY DEUTERONS. Berick, Alan Coleman. Los Angeles, Calif., Univ. of California, 1967. 143p.

Thesis.

The differential cross-section for the elastic scattering of neutrons by deuterons was measured at a neutron energy of 14.3 ±

0.2 MeV. The T(d,n)^{4}He reaction was used as the source of neutrons. The data cover the center-of-mass scattering angles from 13.53 to 158.57° and the cross-section at each angle was measured with a statistical accuracy from 2 to 3%. The scattering target was a deuterated benzene scintillator coupled to a 56AVP photomultiplier tube. The time-of-flight of the scattered neutron was measured by utilizing the recoil deuteron pulse in the target counter to start the timer and a pulse produced by the scattered neutron in a 58AVP photomultiplier tube fitted with a plastic scintillator to stop it. Background events were limited by placing pulse height restrictions on the pulses from the target counter. In some cases this was accomplished through the simultaneous use of both pulse height and time-of-flight in a two parameter analysis, and in the remaining cases by the use of a single channel pulse height analyzer to select the pulse height of the recoil deuteron. The data were normalized to the n-p scattering cross-section at 14.1 MeV. The relative efficiency of the scattered neutron detector at each energy was determined by performing the experiment with a regular hydrogenated benzene scintillator in place of the deuterated sample. The angles chosen for the n-p scattering were those for which the neutron energies were in a one-to-one correspondence with those for the scattering angles chosen for the n-d experiment. The known values of the n-p scattering cross-section could then be used to evaluate the n-d cross section. The neutron flux was monitored by detecting the recoil alpha particles from the T(d,n)^{4}He reaction. The results when compared with those previously obtained at Los Alamos for 14.1 MeV neutrons show a deeper minimum near 120°, a higher value at the forward angles, and agreement in the backward angles. (Disser. Abstr.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 16881, 16889, 17247, 17853, 17973, 18161, 18162, 18166, 18171, 18287, 18313, 18340, 18345, 18350, and 18353.

18122 (NYO-2771-25) NUCLEAR CHEMISTRY RESEARCH: RECOIL STUDIES OF NUCLEAR REACTIONS. Annual Report, January 1967–January 1968. Wolke, Robert L. (Pittsburgh Univ., Pa. Wherrett Lab. of Nuclear Chemistry). Contract AT(30-1)-2771. 61p. Dep. CFSTI.

Research progress on the charge states of recoils from nuclear reactions, recoil spectrometry of (d,n) reactions, and the dating of lead-bearing objects is reported. (D.C.W.)

18123 (RLO-1925-11) NUCLEAR PHYSICS RESEARCH. Progress Report for the Year Ending May 31, 1968. (Oregon Univ., Eugene. Dept. of Physics). Contract AT(45-1)-1925. 164p. Dep. CFSTI.

Useful operating time of the Van de Graaff accelerator has steadily increased during the year. Troublesome high-pressure leak problems in the terminal mostly disappeared after modification of the four-way gas manifold. Changes in the electrical and electronic systems have greatly improved machine reliability, particularly by making operation of the pulsed terminal more dependable. Installation of an SF_6 gas storage system is nearly complete. Neutron-yield measurements as a function of incident energy, utilizing a thick-target method, were completed for deuterons on ^{12}C and ^{16}O. The construction of shielding for neutron scattering studies is continuing, and measurements are beginning. A study of the ^{40}Ca($\underline{d}$,$\underline{n}$)^{41}Sc reaction at energies below the Coulomb barrier was initiated. An in-place evaporator was completed, and several angular distributions were obtained. Precise gamma-ray measurements on the ^{27}Al($\underline{p}$,γ)^{28}Si reaction were completed. Energies, lifetimes, and branching ratios in the de-excitation of ^{28}Si excited states were investigated. A similar study of ^{40}Ca excited states was completed. The usefulness of angular-distribution measurements in capture-gamma experiments with Ge(Li) detectors is being studied through the ^{31}P($\underline{p}$,γ)^{32}S reaction. Work on second-order effects in β decay was extended. Internal ionization during β decay was treated theoretically as a one-step process, using relativistic wave functions and paying attention to antisymmetrization and phase-space considerations. Experiments testing the theory are being continued. (auth)

18124 ELECTRIC MONOPOLE AND QUADRUPOLE EXCITATIONS IN ^{16}O. Stroetzel, M. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 26B: 376-7(Feb. 19, 1968).

Ground-state transition probabilities and transition radii for the levels (E_x in MeV) 6.05(0^+), 6.92(2^+), 9.85(2^+), 11.52(2^+), 12.05(0^+), and 13.1(2^+) of ^{16}O as found by (e,e′) experiments are given. (auth)

18125 STUDY OF THE EXCITED LEVEL AT 2.19 MeV (J = 3^+, T = 0) OF ^{6}Li BY THE METHOD OF RESONANCE GROUPS. Laskar, William; Le Maitre, Roger (Faculte des Sciences, Nantes, France). Compt. Rend., Ser. A and B, 265: 1488-91 (Dec. 18, 1967). (In French).

The elastic d – ^{4}He collision was used to investigate the excited levels T = 0 of ^{6}Li considered as a d – ^{4}He grouping. The variational method applied makes it possible to determine the scattering function by the intermediary of a integrodifferential equation. The problem was solved for certain values of the energy of the incident deuteron; and, for each of these values, three types of forces were studied: empirical Serber forces, WMBH symmetric forces, and Biel forces. The results of the numerical solution are tabulated for incident laboratory deuteron energies of 0.2, 0.933, 1.053, 1.073, 1.093, 3 and 10.3 MeV. (J.S.R.)

18126 ODD-PARITY STATES OF ^{16}O ACCORDING TO THE FERMI LIQUID THEORY. Hacker, K. (Technische Hochschule, Munich); Mikeska, H. J. Phys. Lett., 26B: 357-8(Feb. 19, 1968).

The effect of second-order and spin-orbit contributions to the quasi particle interaction on the odd-parity states of ^{16}O is calculated. The influence of density interpolations is discussed. (auth)

18127 EVIDENCE FOR A TWO-STEP MECHANISM IN A PICKUP REACTION ON ^{12}C. Dupont, Y.; Chabre, M. (Institut des Sciences Nucleaires, Grenoble, France). Phys. Lett., 26B: 362-4(Feb. 19, 1968).

A strong energy dependence is observed for excitation of $5/2^-$ and $7/2^-$ states in the ^{12}C(d,^{3}He)^{11}B reaction between 28 and 50 MeV. A calculation of the two-step process via inelastic excitation of ^{12}C explains the magnitude and energy variation of the cross sections. (auth)

18128 NEUTRONS FROM THICK TARGET BERYLLIUM (d,n) REACTIONS AT 1.0 MeV TO 3.0 MeV. Inada, Tetsuo; Kawachi, Kiyomitsu; Hiramoto, Toshiyuki (National Inst. of Radiological Sciences, Chiba, Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 22-9(Jan. 1968).

The energy and angular distributions as well as the yields of fast neutrons from a thick Be disk bombarded by 1.0- to 3.0-MeV deuterons, observed with the use of time-of-flight technique, are presented. It was ascertained that the water-cooled target assembly of a Be disk 3 mm thick could tolerate beams up to 1.2 kW. Data obtained with the neutrons generated by the present reactions are also reported for practical use in fast neutron irradiation work. (auth)

18129 DETERMINATION OF THE EFFECTIVE CROSS SECTION FOR THE REACTION ^{9}Be(n,2n)2^{4}He BY MEASUREMENT OF THE He CONTENT IN IRRADIATED Be SAMPLES. Robrock, K. H.; Hecker, R. (Kernforschungsanlage, Juelich, Ger.). Nukleonik, 10: 257-9(1967). (In German).

The neutron reactions on ^{9}Be leading to He formation are outlined. The devices designed for the determination of the effective cross section of the ^{9}Be(n,2n)2^{4}He reaction are described, and the measurements made are reported. A value of $\sigma = 400 \pm 50$ mb was obtained for the energy threshold of 2.7 MeV. The agreement of this value with previous results is discussed in some detail. (J.S.R.)

18130 INELASTIC ELECTRON SCATTERING FROM LEVELS AT 19.5-MeV EXCITATION IN ^{12}C. Bishop, G. R. (Univ. of Glasgow). Phys. Rev. Lett., 19: 659-61(Sept. 11, 1967).

An apparently good fit of the summed transverse and longitudinal form factors to the total measured form factor for inelastic electron scattering to the 19-MeV levels of ^{12}C appears less good when the two components are distinguished. Evidence for the T = 1, J = 1^- and T = 1, J = 2^- states seems clearly established, but the longitudinal form factor indicates that another level is contributing. (auth)

18131 STUDIES OF THE ENERGY DEPENDENCE OF p-^{16}O INTERACTIONS BETWEEN 20 AND 50 MeV. I. MEASUREMENTS OF THE DIFFERENTIAL CROSS SECTIONS OF PROTONS ELASTICALLY SCATTERED BY ^{16}O AT 23.4, 24.5, 27.3, 30.1, 34.1, 36.8, 39.7, 43.1, AND 46.1 MeV. Cameron, J. M.; Richardson, J. Reginald; van Oers, W. T. H.; Verba, J. W. (Univ. of California, Los Angeles). Contracts N00014-67-A-0009; AT(11-1)-Gen-10. Phys. Rev., 167: 908-14(Mar. 20, 1968).

Differential cross sections for the elastic scattering of protons by oxygen were measured at mean proton energies of 23.4, 24.5, 27.3, 30.1, 34.1, 36.8, 39.7, 43.1, and 46.1 MeV. The data cover center-of-mass scattering angles from 10 to 165° and have a relative uncertainty smaller than 2%. An oxygen gas target was bombarded with protons obtained, using the variable-energy extraction system of the UCLA sector-focused cyclotron. The scattered protons were detected, using an array of four NaI(Tl) scintillation counters. The results show the existence of strong resonances below 30 MeV which appreciably distort the monotonic energy variation found at the higher energies. The results have been compared with those obtained by other investigators in this energy region. (auth)

18132 STUDIES OF THE ENERGY DEPENDENCE OF p-^{16}O INTERACTIONS BETWEEN 20 AND 50 MeV. II. MEASUREMENTS OF THE POLARIZATIONS OF PROTONS ELASTICALLY SCATTERED BY ^{16}O AT 24.5, 27.3, 30.1, 34.1, 36.8, AND 39.7 MeV. Eldridge, Hudson B.; Bunker, S. N.; Cameron, J. M.; Richardson, J. Reginald; van Oers, W. T. H. (Univ. of California, Los Angeles). Contract 233-(44). Phys. Rev., 167: 915-21 (Mar. 20, 1968).

The polarized proton beam from the UCLA sector-focused cyclotron was used to measure the angular dependence of the polarization in elastic scattering of protons from oxygen at mean proton energies of 24.5, 27.3, 30.1, 34.1, 36.8, and 39.7 MeV. The polarized proton beam was produced by scattering the internal beam from a carbon scatterer. The different proton energies were attained by varying the thickness of the carbon vane and by degrading the external proton beam, using aluminum degraders. A calibration of the beam polarization for the various scatterers was obtained in a separate experiment. A disc of ice 0.032 in. thick by 1.25 in. dia was used as an oxygen target. Four NaI(Tl) integral line detectors were placed two on each side of the incident beam so that protons scattered to the left and to the right at two different angles could be counted at the same time. A solenoid magnet capable of rotating the direction of polarization by ±180° was used, allowing three independent measurements of the left-right asymmetry to be made at each angle. The data obtained for incident proton energies between 30 and 40 MeV exhibit a smooth energy behavior. The data at 24.5 and 27.3 MeV, however, suggest the presence of strong resonances which cause a drastic variation in the polarization angular distribution. A comparison with existing experimental data supports this explanation. (auth)

18133 INTERPRETATION OF THE (d,α) REACTIONS ON ^{19}F AND ^{15}N AT 20.9 MeV. Priest, Joseph R.; Vincent, John S. (Lewis Research Center, Cleveland). Phys. Rev., 167: 933-9 (Mar. 20, 1968).

The differential cross sections corresponding to the production of the first three and first two residual states in the reactions ^{19}F(d,α)^{17}O and ^{15}N(d,α)^{13}C were measured from 17 to 170° and 17 to 112°, respectively, for a deuteron energy of 20.9 MeV (lab). The shapes of the angular distributions are consistent with a cutoff-radius distorted-wave Born-approximation calculation using the zero-range approximation for the nuclear interaction. The best fit was obtained for the ^{19}F(d,α_1)^{17}O which proceeded primarily by $L = 0$ orbital-angular-momentum transfer. Arguments based on the character of the nuclear states involved and the magnitudes of the experimental differential cross sections indicate that the most favorable reaction mechanism is the pickup of a neutron-proton pair from the target nucleus. (auth)

18134 CROSS-SECTION MEASUREMENTS FOR THE NUCLEON-TRANSFER REACTIONS ^{10}B(^{19}F,^{18}F)^{11}B AND ^{10}B(^{19}F,^{18}O)^{11}C. Gaedke, R. M.; Toth, K. S.; Williams, I. R. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 167: 957-62(Mar. 20, 1968). (ORNL-P-3530).

Thick targets of ^{10}B were bombarded with ^{19}F ions accelerated in the Oak Ridge tandem Van de Graaff, and cross sections were measured for the nucleon-transfer reactions ^{10}B(^{19}F,^{18}F)^{11}B and ^{10}B(^{19}F,^{18}O)^{11}C from 10.5 to 26.5 MeV. The amount of ^{18}F and ^{11}C present in each irradiated sample was determined by the detection of the 110- and 20.5-min positron activities, respectively, characteristic of the two nuclides. It was found that the cross section for the neutron-transfer reaction was ~2.5 times greater than that of the proton-transfer reaction. This is in contrast to results obtained previously for similar transfer reactions induced by ^{14}N ions on ^{10}B and ^{14}N targets. Reaction cross sections for the incident ^{14}N to transfer a nucleon to the target nuclei ^{10}B and ^{14}N were measured, and are approximately independent of whether a neutron or a proton is transferred. Previously published data for the reactions ^{14}N(^{14}N,^{13}N)^{15}N, ^{10}B(^{14}N,^{13}N)^{11}B, and ^{14}N(^{19}F,^{18}F)^{15}N, were examined together with the data for the ^{10}B(^{19}F,^{18}F)^{11}B reaction. By applying the tunneling theory of Breit et al., to these results, two values (one for each target nucleus) were extracted for the ratio of the reduced width of the transferred neutron in ^{19}F to that in ^{14}N. Both ratios were found to be ~3.7. The internal consistency lends encouragement to this method of reduced-width extraction. Graphite disks were bombarded with ^{19}F ions, and the yield of ^{18}F from ^{19}F on carbon in the energy range investigated was found to be negligible when compared with that measured for ^{10}B targets. Excitation functions were also measured for the compound-nucleus reactions ^{10}B(^{19}F,αp)^{24}Na, ^{12}C(^{19}F,2p)^{29}Al, and ^{13}C(^{19}F,2α)^{24}Na. (auth)

18135 STUDY OF REACTIONS ^{10}B(p,d)^{9}B AND ^{11}B(p,d)^{10}B. Kull, L. A.; Kashy, E. (Michigan State Univ., East Lansing). Phys. Rev., 167: 963-70(Mar. 20, 1968).

Excited states of ^{9}B and ^{10}B were studied by means of the (p,d) reaction, using 33.6-MeV incident protons. Deuteron groups were observed corresponding to strongly excited levels in ^{9}B at 0.0-, 2.35-, 7.1-, and 11.75-MeV excitation and in ^{10}B at 0.0-, 0.72-, 1.76-, 2.15-, 3.57-, 4.75-, 5.10-, and 6.04-MeV excitation. Small deuteron yields were observed corresponding to excited states in ^{9}B at 2.8- and 14.6-MeV excitation and ^{10}B at 6.57- and 7.5-MeV excitation. The angular distribution for the elastic scattering of 33.6-MeV protons from ^{10}B was measured and was fitted with an optical-model calculation to provide parameters for a distorted-wave Born-approximation (DWBA) analysis of the (p,d) data. Angular distributions were taken for all the levels strongly excited in the (p,d) reaction, and the results compared to a DWBA calculation. Spectroscopic factors were extracted and compared with theoretical intermediate-coupling calculations in the 1p shell and with other (p,d) and (d,t) results. Spin assignments were made for the levels of ^{9}B strongly excited in the (p,d) reaction. Difficulties in matching the shapes of the experimental angular distributions to DWBA calculations for pickup and stripping reactions involving light nuclei are discussed. (auth)

18136 DIFFERENTIAL CROSS SECTIONS FOR THE PRODUCTION OF PROTONS IN THE REACTIONS OF ~160-MeV PROTONS ON NUCLEI. Peelle, R. W.; Love, T. A.; Hill, N. W.; Santoro, R. T. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 167: 981-90(Mar. 20, 1968). (ORNL-P-3346).

Cross sections differential in both angle and energy were obtained by flight-time spectrometry for secondary protons above 20 MeV from 158-MeV protons on Be, C, H_2O, Al, Co, and Bi targets. Enough angles were studied to present rough angular distributions from aluminum and cobalt. All secondary charged particles were assumed to be protons, for which the energy resolution varied from 25 to 50%. The observed differential cross sections change smoothly with angle and target mass, and show no peak corresponding to quasifree scattering near the energy corresponding to free nucleon-nucleon scattering. The measurements are compared with others available at the same incident energy and with estimates based on intranuclear-cascade-plus-evaporation calculations. The observed cross sections are larger than the estimated ones at angles of 90 and 120°, and at low energies for angles more forward than 45°. At 60°, the observed cross sections are in accord with the Monte Carlo estimates. (auth)

18137 MEASUREMENTS AND DISTORTED-WAVE BORN-APPROXIMATION ANALYSES OF SOME 13.9-MeV DIFFERENTIAL CROSS SECTIONS FOR THE ^{14}N(^{3}He,α)^{13}N REACTIONS. Lucas, B. T.; Ober, D. R.; Johnson, O. E. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1420. Phys. Rev., 167: 990-5 (Mar. 20, 1968). (COO-1420-138).

The (^{3}He,α) differential cross sections leading to the ground and 2.367-, (3.51 + 3.56)-, 6.38-, and (7.18 + 7.42)-MeV states ^{13}N were measured at an incident ^{3}He energy of 13.9 MeV using silicon surface-barrier detectors and a conventional electronic spectrometer system. Energy spectra were accumulated at 2.5° intervals over a laboratory angular range 17.5 to 90° and at 5° intervals from 90 to 170°. The experimental differential (^{3}He,α) cross sections corresponding to states in ^{13}N at 0, 2.367, 6.38, and (7.18 + 7.42) MeV exhibit a pronounced oscillatory structure, suggesting that a direct-reaction mechanism is dominant. The composite cross section corresponding to the transitions leading to the (3.51 + 3.56)-MeV doublet has a somewhat washed-out structure. All angular distributions display a definite forward-angle peaking, and those leading to the ground and 2.367- and (3.51 + 3.56)-MeV states of ^{13}N show evidence of strong backward-angle peaking. The transitions leading to the odd-parity states in ^{13}N appear to be considerably enhanced relative to those leading to the even-parity states. The angular distributions corresponding to the transitions to the ground and 2.367- and 6.38-MeV states were analyzed within the framework of the zero-range distorted-wave theory using a simple knockout model. The use of cutoff radii equal to or slightly larger than the nuclear radius was necessary in order to obtain reasonably good representations of the experimental data. (auth)

18138 SPIN-ORBIT DOUBLET SEPARATION IN ^{17}O USING HARD-CORE HARMONIC-OSCILLATOR WAVE FUNCTIONS. Niblack, W. K. (State Univ. of New York, Buffalo. Motorola Semiconductor Lab., Phoenix, Ariz.); Nigam, B. P. Phys. Rev., 167: 996-1012(Mar. 20, 1968).

Calculations of the spin-orbit doublet separation in ^{17}O are performed. It is assumed that, to a first approximation, the individual-particle potential experienced by each nucleon in the nucleus is given by the harmonic-oscillator potential. In this approximation the two-nucleon wave function for nucleons in the nucleus is separable in their relative and center-of-mass coordinates so that, taking into account only two-body interactions which depend on the relative coordinate, the K matrix elements are essentially functions of quantum numbers of relative motion only and of the relative space coordinate. The nucleus ^{17}O is considered as consisting of the nucleus ^{16}O as a core plus a neutron outside. The spin-orbit doublet separation is the difference in energy of ^{17}O with the outside neutron in the states $J = {}^5\!/_2$ and ${}^3\!/_2$, and is evaluated in the approximation of taking interactions of the outside neutron with each of the sixteen core nucleons and neglecting interactions between nucleons in the core. Numerical calculations are done using only the spin-orbit part of the Gammel-Thaler potential, but treating it as a perturbation using hard-core harmonic-oscillator wave functions as the unperturbed wave functions. A value of 5.95 MeV is obtained for the spin-orbit splitting. (auth)

18139 SELF-CONSISTENT BINDING ENERGIES AND DENSITIES OF PROTONS AND NEUTRONS IN ^{10}Be AND ^{10}C. Faessler, Amand (Univ., Muenster, Ger.); Sauer, P. U.; Stingl, M. M. Phys. Rev., 167: 1013-15(Mar. 20, 1968).

Binding energies, root-mean-square radii, and deformations of the protons and neutrons are calculated for the prolate and the oblate energy minima in ^{10}Be and ^{10}C, utilizing the Hartree-Fock approach. The nucleons interact via the Volkov and the Coulomb force. The energies are corrected for the cms motion. The mass and the charge distribution are surprisingly different; the theoretical charge deformation in ^{10}Be is $\beta_C = 0.62$ [β_C(expt) = ±0.7 ± 0.1], while the calculated mass deformation has the value $\beta_M = 0.41$. A division of the total binding energy into a proton and a neutron part yields for ^{10}Be twice as large a contribution for the protons as for the neutrons. This puzzle can be understood by means of Wigner's SU_4 model. (auth)

18140 INELASTIC SCATTERING IN THE 2s–1d SHELL. II. ODD-A NUCLEI. Crawley, G. M.; Garvey, G. T. (Princeton Univ., N. J.). Phys. Rev., 167: 1070-90(Mar. 20, 1968).

The inelastic scattering of 17.5-MeV protons from ^{19}F, ^{23}Na, ^{25}Mg, ^{27}Al, and ^{31}P was studied with lithium-drifted silicon detectors with an over-all energy resolution of order 50 keV. Differential cross sections are presented for most of the low-lying levels. Using previously obtained data for the adjacent even-even nuclei, the results are compared with the predictions of strong- and weak-coupling models. The results are most consistent with strong coupling for ^{19}F, ^{23}Na and ^{25}Mg, while ^{27}Al and ^{31}P seem to be more consistent with weak coupling, although extensive mixing is required in ^{27}Al. The differential cross section for the most strongly excited levels are compared with a distorted-wave Born-approximation calculation using collective form factors. Reasonable fits for l = 2 excitations in ^{11}F, ^{27}Al, and ^{31}P and l = 3 transitions in ^{31}P are obtained, and the appropriate reduced transition strengths are extracted. Previously unreported levels are observed in ^{23}Na (5.38, 5.76, and 5.94 MeV), ^{27}Al (7.66, 7.79, and 7.99 MeV), and ^{31}P (5.34 MeV). (auth)

18141 ELASTIC SCATTERING OF 14.8-MeV NEUTRONS FROM ^{14}N AND ^{16}O. Lundberg, B.; Schwarz, S.; Zetterstroem, H. O. (Research Inst. of National Defence, Stockholm). Ark. Fys., 34: 247-57(1967).

Differential cross sections for neutrons elastically scattered from ^{14}N and ^{16}O were measured at a mean energy of 14.8 MeV. The scattering samples were NH_3 in liquid phase and H_2O enclosed in thin-walled ring-shaped vessels. The neutrons produced by the T(d,n)^{4}He reaction with deuterons from a high-voltage generator were detected by a small plastic scintillator, biased above the inelastically scattered neutrons, and monitored by a recoil alpha counter. (auth) (Sweden)

18142 THE TOTAL CROSS SECTION OF THE REACTION ^{12}C(d,n)^{13}N FOR DEUTERONS OF 0.4 TO 3.0 MeV. Wohlleben, K.; Schuster, E. (Siemens Aktiengesellschaft, Erlangen, Ger.). Radiochim. Acta, 8: 78-82(Nov. 1967). (In German).

The reaction ^{12}C(d,n)^{13}N is suitable for the determination of carbon by activation analysis. With thick target irradiation, the induced ^{13}N activity is proportional to the product of the activation depth D* and the cross section σ* averaged over D*. D* is the difference in the ranges of deuterons between the bombarding energy and the threshold energy at 0.329 MeV. With SiC as standard, the value of σ*D* was measured for 16 discrete deuteron energies between 0.4 and 3.0 MeV. The range energy relation for deuterons in SiC was calculated with the experimental values of the stopping cross section in Si and C. D*, and consequently σ*, were thus determined. (auth)

18143 INELASTIC ELECTRON SCATTERING AT 180° ON ^{12}C. Proca, G. A.; Isabelle, D. B. (Ecole Normale Superieure, Orsay, France). Nucl. Phys., A109: 177-200(1968).

Using a special set-up described in the paper, inelastic electron scattering was performed on ^{12}C at 180°. The cross sections were measured for the eight strongly excited states with $E_x = 14$ to 21 MeV and for various momentum transfers. Information about spin, parity, radiative width, and isospin of the excited states is derived. The electro-excitation of the giant dipole resonance is also discussed. (auth)

18144 THE 2I + 1 RULE AND THE REACTION MECHANISM OF THE ^{19}F(d,α)^{17}O REACTION. Takeuchi, Y.; Hiratate, Y.; Miura, K.; Tohei, T.; Morita, S. (Tohoku Univ., Sendai). Nucl. Phys., A109: 105-17(1968).

The reaction ^{19}F(d,α)^{17}O was studied in the deuteron energy range from 0.9 to 4.25 MeV. Angular distributions and excitation functions were obtained for the alpha-particle groups leading to the five lowest states of ^{17}O. The 2I + 1 rule was examined; good agreement with theory was obtained except near thresholds for other reactions. The intercept of the 2I + 1 line with the ordinate was analyzed theoretically. It was found that the ratio of the gradient to the intercept of the 2I + 1 line is equal to 1/(2i + 1), where i is the spin of the incident particle. Some evidence of interference between the compound nuclear and direct reaction mechanism was found in the excitation function for the α_2 group. (auth)

18145 FORM FACTORS OF ^{6}Li. Bouten, M. (SCK-CEN, Mol, Belg.); Bouten, M. C.; Van Leuven, P. Phys. Lett., 26B: 191-3(Jan. 22, 1968).

It is shown that the magnetic and charge form factors of ^{6}Li are in satisfactory agreement with those obtained from a projected Hartree–Fock calculation. (auth)

18146 PRIMARY STANDARD DATA AND STANDARD SAMPLES. Spaepen, J. (Central Bureau for Nuclear Measurements, Geel, Belg.). pp 241-65 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

The accuracy requirements for primary standard cross sections, in the interval from thermal energy to 15 MeV, are derived from the needs for precise neutron data, requested for reactor purposes. The accuracy attained at present for possible standard cross sections is discussed, and the situation is reviewed as far as the properties of corresponding samples and detectors are concerned. The ^{10}B(n,α)^{7}Li, ^{7}Li* (below 100 keV) and ^{1}H(n,n) (above 100 keV) cross sections are proposed as primary standards for flux measurements; and recommended values are given, where possible. On the other hand, energy regions where improvement of accuracy is still needed, are indicated. Suggestions for future work are given in the conclusions. It is pointed out, in particular, that a high-precision measurement of the ^{10}B(n,α) cross section near 100 keV would establish a sufficiently accurate primary standard in the 1 to 100-keV region if the cross section behaves still as 1/V at 100 keV. The suggestions pertain also to secondary working standards of which a brief list is given, without, however, reviewing the present status in detail. (auth)

18147 MEASUREMENT OF THE CROSS SECTION OF THE REACTION ^{6}Li(n,α)T BY THE ASSOCIATED-PARTICLE METHOD. Fort, E.; Leroy, J. L. (CEN, Cadarache, France). pp 267-75 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol. 1); CONF-661014-(Vol. 1).

The neutrons are produced by the T(p,n)^{3}He reaction. The ^{3}He particles associated with neutrons are detected in a direction making an angle of 10° with the incident proton beam. This detection is made possible by using a tritium–titanium target on a thin backing of copper, and a spectrometer selecting particles according to their charge. Under beam bombardment, the target emits protons of various energies by elastic and inelastic scattering on copper and titanium, together with recoil tritons and ^{3}He particles. These latter are selected by the spectrometer, which is mainly composed of an electrostatic analyzer and a silicon solid-state detector. In a second run of measurements, a magnetic separator was added to the device to eliminate completely parasitic protons. Neutrons associated with detected ^{3}He particles pass through a ^{6}Li-loaded glass scintillator. The ^{6}Li content was determined by a measurement of thermal neutron absorption, using the pile oscillator method. The detector efficiency is equal to the ratio of the number of coincidences between neutrons and ^{3}He particles to the total number of ^{3}He particles detected. The Coulomb scattering of ^{3}He particles in the target induce a dispersion in energy and direction of associated neutrons. A Monte Carlo calculation was made to correct for coincidences lost by this effect and for multiple scattering of neutrons in the scintillator. The resulting cross section is 3.00 ± 0.1 b at 255-keV neutron energy. Measurements were carried out in the range between 150 and 280 keV. Further improvements to the method are proposed. (auth)

18148 ANGULAR CORRELATIONS AT E_d = 1.6 MeV IN THE $^{19}F(d,p_1\gamma)^{20}F$ REACTION. Calvi, G.; Cavallaro, S.; Figuera, A. S.; Sandoli, M. (Univ., Catania, Italy). Nuovo Cim. (10), 53B: 485-93(Feb. 11, 1968).

The (d,pγ) angular correlations of the proton group corresponding to the 0.65-MeV level of ^{20}F produced in the reaction $^{19}F(d,p_1)^{20}F$ were measured at E_d = 1.6 MeV. The measurements were carried out in the reaction plane and in two azimuthal planes for a proton emission angle of 45°. The experimental points were fitted by a sum of even-order Legendre polynomials. The best fits obtained, including polynomials to the sixth order, seem to agree better with the experimental points. Taking into account this result, a possible presence of more reaction mechanisms is suggested. (auth)

18149 STUDY OF THE ANGULAR DISTRIBUTION OF α_0 PARTICLES EMITTED DURING THE REACTION $d + {}^{10}B \rightarrow \alpha_0 + {}^8Be$. Lemeille, Claude; Marquez, Luis; Saunier, Noelle (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 265: 1050-3(Nov. 6, 1967). (In French).

The angular distribution and the excitation functions of the α particles corresponding to the ground state of ^8Be were studied in the reaction $d + {}^{10}B \rightarrow \alpha_0 + {}^8Be$. The energy of the incident deuterons was between 3 and 7.2 MeV. (tr-auth)

18150 AUTOMATIC MEASUREMENT OF A REACTION YIELD ON THE ELECTROSTATIC ACCELERATOR OF THE PHYSICO-TECHNICAL INSTITUTE OF THE UKRAINIAN ACADEMY OF SCIENCES. Yamnitskii, V. A.; Makarov, A. F.; Kopanets, E. G.; Korda, Yu. S.; Tsytko, S. P.; Zeidlits, P. M. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 2000-9(Dec. 1967). (In Russian).

A system is described which makes it possible to apply successfully the Dnieper computer in measuring an excitation function of the reactions of radiation capture and inelastic scattering of protons by light nuclei. The program occupies about 1000 addresses and about 1000 addresses are taken for the set of information. The program provides repeated measuring of the output at one and the same proton energy, error computing, and energy step change when approaching resonance. The proton energy value (in keV) and the reaction yield are typed and perforated and diagrammed. Automation helps to reduce the machine time of an accelerator to the factor of 3 and the time of obtaining the experimental data to the factor of 20. (auth)

18151 RECOIL STUDIES OF THE REACTION $^{12}C(p,pn)^{11}C$ FROM THRESHOLD TO 85 MeV. Hontzeas, S. (McGill Univ., Montreal). Can. J. Chem., 46: 267-77(Jan. 1968).

To survey the features of the simple $^{12}C(p,pn)^{11}C$ reaction from threshold to 85 MeV, data were obtained for average projected ranges of ^{11}C along and perpendicular to the beam direction. The data from threshold to 45 MeV provide evidence for a large momentum transfer mechanism of the compound-nucleus type. In the 45 to 85-MeV energy region the data were analyzed in terms of a vector model consistent with the cascade-evaporation mechanism. More detailed information regarding differential ranges and angular distributions are needed if the recoil parameters are to provide conclusive results. (auth) (CANADA)

18152 MEASUREMENTS OF THE ENERGY DEPENDENCE OF THE PROTON TOTAL REACTION CROSS SECTIONS OF CARBON AND OPTICAL MODEL ANALYSES OF PROTON-CARBON ELASTIC SCATTERING. Makino, Motoji Quincy. Los Angeles, Calif., Univ. of Southern California, 1967. 126p.
Thesis.

Measurements of the proton total reaction cross sections of carbon using the attenuation technique for proton energies between 16 and 28 MeV are described, the measured cross sections are given, and the results of optical model analyses of all available data on proton elastic scattering from carbon in this energy range are presented. The results of the optical model analyses indicate that a small value of the real radius parameter (1.00 fermi) is necessary to fit the polarization measurements, and a larger value (1.25 fermi) is required for the imaginary radius parameter. The predicted total reaction cross sections above 20 MeV are in excellent agreement with the experimental results. However, below 20 MeV it is found that the predicted reaction cross sections are lower than the experimental cross sections. (Disser. Abstr.)

18153 A STUDY OF THE ^9Be NUCLEUS. Cocke, Charles Lewis Jr. Pasadena, Calif., California Inst. of Tech., 1967. 199p.
Thesis.

The reaction $^7Li(^3He,p)^9Be$ was used to measure excitations and intrinsic widths of levels in ^9Be below the $^7Li + d$ threshold. Previously unreported levels were found at excitations of (13.78 ± 0.03) MeV and (16.671 ± 0.008) MeV with widths of (590 ± 60) keV and (41 ± 4) keV respectively. Two overlapping levels were found at (11.81 ± 0.02) MeV and (11.29 ± 0.03) MeV with widths of (400 ± 30) keV and (620 ± 70) keV respectively. Branching ratios from ^9Be levels populated in this reaction to the ground and first excited states of ^8Be were measured by observing the associated protons in coincidence with the decay neutrons. Corresponding reduced widths for neutron emission are calculated and a comparison of the results with the expectations of current nuclear models is made. In particular the measured branching ratio to ^8Be(g.s.) from ^9Be(2.43 MeV) corresponds to an f-wave reduced width of $\theta_f^2 = 2.1 \times 10^{-2}$, in units of $\hbar^2/mR^2$, with R = 4.35 fm. A comparison of this value with that predicted by a Nilsson model calculation, in which ^9Be is taken to be a deformed nucleus, is discussed. The measured value for θ_f^2 is found to be consistent with that expected on the basis of measured E2-transition rates between rotational levels in ^9Be. (Disser. Abstr.)

18154 A STUDY OF THE REACTION $^6Li(^{12}C,d)^{16}O$ ABOVE THE COULOMB BARRIER. Zaidins, Clyde Stewart. Pasadena, Calif., California Inst. of Tech., 1967. 152p.
Thesis.

The angular distributions of deuterons from the reaction $^6Li(^{12}C,d)^{16*}O$ leading to the ground state and first eight excited states of ^{16}O were measured at a center-of-mass energy of 7 MeV. The angular distributions of deuterons leading to the third, fourth, and fifth excited states were also measured at 8 MeV, and excitation functions for these levels at θ_{LAB} = 30 and 50° were taken for these levels from 6 to 8 MeV. The results are analyzed by calculating a theoretical contribution to the total cross sections due to the formation and decay of the compound nucleus ^{18}F in a statistical region of excitation by a Hauser–Feshbach calculation. This contribution is then subtracted from the total, neglecting any interference effect, and the difference is related to a reduced alpha width of the ^{16}O final states that might be measured in a purely direct alpha transfer reaction. The astrophysical significance of the reduced alpha width of the fourth excited state is discussed. (Disser. Abstr.)

18155 POLARIZATIONS AND CROSS SECTIONS FOR ELASTIC AND INELASTIC PROTON SCATTERING FROM ^9Be. Kostoff, Morris Raymond. Austin, Tex., Univ. of Texas, 1967. 90p.
Thesis.

Differential cross section and absolute polarization angular distributions were measured for protons elastically scattered from ^9Be in the laboratory energy range from 7.0 to 11.0 MeV. The inelastic differential cross sections for protons scattered from the 2.43 MeV level in ^9Be were also measured for the same energies. At 11.0 MeV a polarization angular distribution for the 2.43 MeV proton group was also observed. The experimental apparatus and its application as a "calibrated" polarimeter are described in detail. A method for the fabrication of thick self-supporting carbon foils is described briefly. The data are analyzed using a diffuse surface optical model parameter search routine. The data were fit initially with six parameters. In this scheme the spin-orbit diffuseness parameter was set equal to the real diffuseness parameter. The remaining five parameters were the real, imaginary, and spin-orbit well depths, the imaginary diffuseness parameter, and the radius parameter. The results were only fair. Two different seven parameter searches were also accomplished. The first allowed the spin-orbit radius to search in addition to the parameters varied in the six parameter search. This scheme resulted in fits very similar to those of the six parameter search. The second seven parameter search allowed the spin-orbit diffuseness parameter to vary rather than the spin-orbit radius. This fitting procedure resulted in extremely good fits to both the polarization and the cross section data. The parameters vary smoothly with energy and the best fits are obtained for a radius parameter of r_0 = 1.40 fermis. This value of r_0 agrees very well with the results of electron scattering experiments. The parameters at 10.0 MeV were used to predict the data at 11.0 MeV and the 14.5 MeV polarization data taken at Los Alamos Scientific Laboratory. Various extrapolations of the 8.5 and 10.0 MeV parameters were also used to predict the data just described. (Disser. Abstr.)

18156 A STUDY OF THE $^{16}O(^3He,n)^{18}Ne$ REACTION BETWEEN 7.6 AND 10.0 MeV. Robbins, John Alan. Rochester, N. Y., Univ. of Rochester, 1967. 229p.
Thesis.

Excitation curves and angular distributions of neutrons from the $^{16}O(^3He,n)^{18}Ne$ reaction leading to the ground state and first three excited states of ^{18}Ne were measured at several ^3He energies from 7.6 to 10 MeV by use of a neutron time-of-flight spectrometer. The ground state angular distributions, especially at higher energy, show excellent stripping patterns characterized by an L = 0 orbital angular momentum transfer. Application of the plane wave double stripping theory of Newns to the ground state data reveals a systematic dependence of the interaction radius on incident energy. No satisfactory plane wave fits were obtained for excited state distributions. A zero-range distorted wave calculation which treats the transferred diproton as a structureless, zero-spin particle yields cross section shapes in excellent agreement with the measured ones for all states. The first excited state transition can be characterized by an L = 2 transfer while the shape of the unresolved second and third excited state distribution is consistent with a linear combination of L = 0 and L = 4 DWBA cross sections. A broad maximum observed near threshold in the ground and first excited state excitation curves is predicted by both the plane and distorted wave theories for stripping reactions with negative Q values. A satisfactory account of the gross energy dependence of the cross sections in terms of the direct interaction model supports the assumption that the scattering is dominated by a stripping process in this energy region. The computer program DRC, written to calculate DWBA cross sections for single nucleon transfers, was modified so as to permit study of the effects of allowing the two transferred nucleons to be captured into discrete shell model orbits. The usual distorted wave amplitude, β^{Lm}, is replaced by a coherent sum of amplitudes describing the probability of absorption of a pair of nucleons into states with different radial quantum numbers. The striking effect of this coherence property on DWBA discrete orbit cross sections is illustrated by use of several alternative forms of the residual interaction between protons captured into s-d shell orbits. The shapes of the discrete orbit angular distributions are much less satisfactory than those calculated in the diproton approximation and the predicted magnitudes of the relative cross sections are consistently less than the measured ones. Both the diproton and discrete orbit DWBA cross sections exhibit great sensitivity to changes in the radial cut-off and to the shape of the bound state wave function in the nuclear interior. Furthermore, the cross section is found to depend strongly on certain optical model parameters. Such effects appear to be attributable to the low reaction Q and use of ^{3}He real potential wells of intermediate depth. A study of the positive Q value isobaric analogue reaction ^{16}O(T,p)^{18}O at 10 MeV triton energy shows more consistent results. The angular distribution data of Middleton and Pullen for the ground state and first nine excited states of ^{18}O are analyzed according to both the diproton and discrete orbit models. The calculated discrete orbit cross sections are in rough agreement with experiment and consistent with known properties of the states of ^{18}O, provided that one assumes a Rosenfeld or realistic (Bruckner–Gammel–Thaler) residual interaction between neutrons captured into s-d shell orbits. Cross sections for transitions leading to final states containing large collective admixtures are underestimated by the theory. The relative cross section for the transition to the 4+ (3.55 MeV) state of ^{18}O is badly underestimated by the discrete orbit calculation. It is conjectured that the discrepancy may be due at least in part to the neglect of coupled channel effects which increase in importance with increasing L. The use of the local energy approximation to obtain finite range and nonlocality corrections to the zero-range DWBA cross sections does not lead to significant improvement in the analysis. (Disser. Abstr.)

18157 AN INVESTIGATION OF TWO AND THREE NUCLEON CLUSTERING IN ^{11}B, ^{15}N, AND ^{19}F USING (α,Li) REACTIONS AT AN INCIDENT ENERGY OF 42 MeV. Mizera, Paul Francis. Seattle, Univ. of Washington, 1967. 111p.

Thesis.

The (α,^{7}Li) and (α,^{7*}Li 0.478) reactions on ^{11}B, ^{15}N, and ^{19}F leading to the ground states of ^{8}Be, ^{12}C, and ^{16}O and to the first excited state of ^{12}C were performed using 42 MeV alpha particles. In addition, (α,^{6}Li) reactions on ^{15}N and ^{19}F leading to the ground states of ^{13}C and ^{17}O and to the first excited state of ^{17}O were analyzed. These angular distributions were compared with distorted-wave Born approximation calculations using a one cluster pickup mechanism and reasonable agreement was found. Certain approximations in the DWBA analysis are discussed and qualitative suggestions are made to correct some of the deficiencies arising from these approximations. Relative reduced widths for triton clustering in ^{11}B, ^{15}N, and ^{19}F were extracted from the experimental angular distributions using the DWBA analysis. These extracted reduced widths are compared to independent particle model calculations employing various approximations in order to determine to what extent three nucleon clustering is present. The results show that the extracted triton reduced widths for ^{11}B and ^{15}N are consistent with those calculated using the independent particle model. The extracted reduced width for ^{19}F is much larger than that calculated from the independent particle model. (Disser. Abstr.)

18158 OBSERVATION OF ^{14}C(p,α)^{11}B REACTION AT BOMBARDING ENERGIES FROM 2.0 TO 3.6 MeV. PART I. TRITIUM–TITANIUM TARGET DEGRADATION STUDIES. PART II. Hashmi, Syed Ziaur Rehman. Austin, Tex., Univ. of Texas, 1967. 74p.

Thesis.

The differential cross sections for the ^{14}C(p,α)^{11}B reaction and for the ^{14}C(p,p)^{14}C elastic scattering were measured for bombarding energies $2.0 \le E_p \le 3.6$ MeV and at laboratory angles of 90, 121.8, 138.3, and 163.8°. The reaction has not been hitherto observed, and the ^{14}C(p,p)^{14}C scattering data represent an extension into the region $E_p > 2.8$ MeV. Several resonances in both the reaction and scattering processes were found, and these are generally correlated in position and width with those found in previous studies of the ^{11}B(α,p)^{14}C, ^{14}N(n,p)^{14}C, and ^{14}N(n,α)^{11}B reactions. Although this work was not intended as a critical test of time reversal invariance, comparisons of differential cross sections at several bombarding energies for the inverse reactions ^{14}C(p,)^{11}B and ^{11}B(α,p)^{14}C were made through application of the principle of detailed balance. The comparisons are generally satisfactory, but more extensive work on this point is indicated. The differential cross section for ^{14}C(p,α)^{11}B at $\theta_{lab} = 90°$ was also measured in the region of the resonance at $E_p = 2.5$ MeV, corresponding to formation of a $T = 3/2$ level in ^{15}N. The emission of alpha-particles from this level is isospin-forbidden, and it is believed that those which were observed come from a nearby level for which $T = 1/2$. A study of the mechanism of deterioration of T/Ti targets under bombardment by 150 keV deuterons yielded the following results: Surfaces throughout the accelerator showed characteristic Ti K x ray activity. This is taken as evidence for "hydride" formation. Target deterioration is accompanied by actual loss of tritium from the target; the building up of a carbon film, as sometimes hypothesized, is not the cause of deterioration. Most of the tritium is apparently lost in gaseous form and is exhausted through the forepump. (Disser. Abstr.)

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Refer also to abstracts 16786, 16882, 16889, 18123, 18136, 18140, 18205, 18212, 18232, 18252, 18256, 18267, 18285, 18287–18289, 18322, 18330, and 18345.

18159 ISOBARIC ANALOGUE STATES IN STRONTIUM ISOTOPES. Debertin, K.; Hagedorn, W.; Roessle, E. (Univ., Freiburg i. B.). Z. Phys., 210: 216-22(Feb. 12, 1968).

Excitation functions for the reactions ^{87}Rb(p,n)^{87}Sr and ^{85}Rb(p,n)^{85}Sr were measured in the energy range 2.3 to 5.6 MeV. Some isobaric analogue states in the compound nuclei ^{88}Sr and ^{86}Sr were found. The Coulomb displacement energy for the isobaric pair ^{88}Sr – ^{88}Rb was deduced. (auth)

18160 DECAY OF ^{59}Fe AND EXCITED LEVELS OF ^{59}Co. Beraud, Robert; Berkes, Istvan; Daniere, Joannes; Levy, Michele; Marest, Gilbert; Rougny, Robert (Institut de Physique Nucleaire, Lyon). Compt. Rend., Ser. A and B, 265: 1354-6(Dec. 6, 1967). (In French).

The energies and intensities of the transitions between the excited levels of ^{59}Co were determined with precision by means of a Ge(Li) detector. The half-life of the excited level at 1,291.5 keV was measured by the delayed coincidence method. A scheme for the decay of ^{59}Fe to ^{59}Co is proposed. (tr-auth)

18161 LIFETIME OF THE 5.14-MeV STATE IN ^{22}Ne. Roepke, H. (Univ., Freiburg i. B.); Pelte, D. Z. Phys., 210: 179-81(Feb. 12, 1968).

Using the delayed coincidence method and the reaction ^{19}F(α,pγ)^{22}Ne at 10.80-MeV alpha energy, the lifetime of the 5.14-MeV state in ^{22}Ne was determined to be 0.84 ± 10% nsec. (auth)

18162 EXPERIMENTAL EVIDENCE FOR LOW-LYING SHELLS FROM PHOTONUCLEAR CROSS SECTIONS. Cook, B. C.; Anderson, D. W.; Englert, T. J. (Ames Lab., Iowa). Phys. Lett., 26B: 341-3(Feb. 19, 1968). (IS-1643).

Systematic measurements of photonuclear cross sections above the giant resonance as a function of atomic number A were performed in the nuclear s-d shell. Structure is found in the cross section for all nuclei measured. The energy for the higher energy peaks is well represented by a family of straight lines of the form: $E_p = mA + 8$ MeV with differing slope m. One of these lines agrees well with the position of the (1s) binding energy as measured in (e,e′p) experiments. This agreement strongly suggests that the structure represents single nucleon excitation of 1s particles to the continuum analogous to the photoelectric effect in atoms. (auth)

18163 ISOSPIN-FORBIDDEN ANALOG RESONANCES IN A = 25 AND 29 QUARTETS. Teitelman, B.; Temmer, G. M. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Lett., 26B: 371-3(Feb. 19, 1968).

The sharp resonances corresponding to the $T = 3/2$, $T_z = -1/2$ states in ^{25}Al and ^{29}P were located by isospin-forbidden elastic and inelastic proton scattering on ^{24}Mg and ^{28}Si, and their widths were determined (of the order of 100 eV). The masses of the $T_z = -3/2$ members are calculated. (auth)

18164 DEPENDENCE OF THE EXCITATION CROSS SECTION FOR ^{27}Al(d,α)^{25}Mg ON THE ROTATIONAL BAND OF ^{25}Mg. Hofmann, A.; Emmerich, W.; Dinter, H.; Philipp, G. (Univ., Erlangen Ger.). Phys. Lett., 26B: 378-9(Feb. 19, 1968). (In German).

The direct contribution of the ^{27}Al(d,α)^{25}Mg cross section is found to be constant for α-particle groups corresponding to states of the same rotational band in ^{25}Mg. (auth)

18165 POSITIVE-PARITY LEVELS IN ^{36}S OBSERVED IN THE ^{37}Cl(d,^{3}He)^{36}S REACTION. Gray, W. S.; Wei, T.; Janecke, J.; Polichar, R. M. (Univ. of Michigan, Ann Arbor). Phys. Lett., 26B: 383-5(Feb. 19, 1968).

Transitions to the ^{36}S ground state and excited states at 3.30, 4.57, 6.51, 7.11 and 7.69 MeV were observed in the reaction ^{37}Cl(d,^{3}He)^{36}S at a bombarding energy of 28.9 MeV. Using distorted-wave analysis, l-values and strength coefficients C^2S were extracted from the measured angular distributions. The results are in reasonable agreement with calculations by Glaudemans et al. (auth)

18166 $T = 3/2$ LEVELS IN ^{21}Na. McDonald, A. B.; Adelberger, E. G. (California Inst. of Tech., Pasadena). Phys. Lett., 26B: 380-2(Feb. 19, 1968).

$T = 3/2$ levels in ^{21}Na were seen at excitation energies of 8.99 ± 0.05 and 9.221 ± 0.015 MeV in the reaction ^{19}F(^{3}He,n)^{21}Na. Angular distributions lead to a spin assignment of $1/2^+$ for the 9.221 level. (auth)

18167 MEAN EFFECTIVE CROSS SECTION OF THE REACTION ^{34}S(n,γ)^{35}S FOR THERMAL NEUTRONS. Kohler, W.; Knopf, K. (Technische Hochschule, Munich). Nukleonik, 10: 278-(Nov. 1967). (In German).

The effective cross section of the reaction ^{34}S(n,γ)^{35}S was determined to be 33.7 ± 3.6 mb. (tr-auth)

18168 THERMAL NEUTRON CAPTURE GAMMA-RAY TRANSITIONS IN THE LOW-LYING STATES OF ^{57}Fe. Honzatko, J.; Eissa, E. A.; Konecny, K. (Nuclear Research Inst., Rez, Czechoslovakia). Czech. J. Phys., 18: 248-50(1968).

The decay scheme of ^{57}Fe in the energy region below 2 MeV was constructed by the precise measurement of the gamma-ray energies using a Ge(Li) detector. The absolute intensities of the observed lines are tabulated. (auth)

18169 INVESTIGATION OF THE POSSIBILITY OF DESCRIBING ^{77}Se AS A DEFORMED NUCLEUS. Engels, Walter (Univ., Bonn). Z. Naturforsch., 22A: 2004-10(Dec. 1967). (In German).

Some aspects of ^{77}Se are discussed in the framework of the Nilsson model. The magnetic moment of the 248-keV state gives a hint for the existence of a quadrupole force. The large quadrupole moment and the large Coulomb excitation and (d,d′) cross sections of some levels indicate collective features. The strong-coupling model explains very well the ratio of the reduced B(E2) transition probability. The Nilsson model predicts the spin and the parity of the ground state and gives a better description of the lifetime of the 248-keV level than the spherical shell model. The magnetic moments of the ground state and the 248-keV state are explained by means of a spin polarization. The agreement of several values of the decoupling constant is fairly good. On the whole, the description of ^{77}Se by the Nilsson model appears to be comparable to the modest success of this model in some rare-earth nuclei. (auth)

18170 MULTIPLE AND PLURAL SCATTERING OF FISSION FRAGMENTS. Kerr, D.; Siegert, G.; Kuerzinger, K.; Konecny, E.; Ewald, H. (Univ., Giessen, Ger.). Z. Naturforsch., 22A: 1799-1807(Nov. 1967).

The multiple scattering distributions of fission fragments in Au, Ag, and Formvar foils were measured. The value of the Born parameter in this experiment is more than an order of magnitude larger than values that have previously been involved in such measurements. Since the fission fragments are only partially ionized, some approximation must be made to account for the additional electronic screening. Two different models, which may have some application to other experiments involving partially ionized particles are presented. The experimental distributions are compared with those predicted by the theories of Moliére and of Nigam, Sundaresan and Wu and only with the theory of Moliére is it possible to obtain reasonable and consistent agreement with experiment. (auth)

18171 LEVEL DENSITY OF LIGHT NUCLEI. Gadioli, E.; Zetta, L. (Univ., Milan. Istituto Nazionale di Fisicia Nucleare, Milan). Phys. Rev., 167: 1016-26(Mar. 20, 1968).

The level density of light nuclei ($A \leq 70$) is studied by analyzing statistical reaction spectra, slow-neutron resonances, and level widths at high excitation energy. Further evidence seems to indicate that, as proposed in a preceding work, the effective excitation energy of excited nuclei, appearing in the Lang–Le Couteur level-density formula, must be calculated by means of the following expression: $U = (E - \Delta + 70/A)$ MeV. E is the usual excitation energy, Δ is the pairing energy, and 70/A MeV is a term that shifts, in a smooth manner, the zero of the energy scale of different nuclei. In this case the Lang–Le Couteur formula, assuming $R \cong 1.5A^{1/3}$ F, $I = 0.7I_{\text{rig}}$, $a = (0.127A)$ MeV^{-1}, gives, without further changes of its parameters, a correct estimation of the slope and absolute value of the level densities of light nuclei for energies ranging from $(1 + \Delta)$ up to ~20 MeV. It is also shown that the preceding choice of the parameters of Lang–Le Couteur level-density expression allows one to reproduce very well the experimental distributions of low-energy levels observed with reactions which proceed, at least partially, through the formation of a compound nucleus. (auth)

18172 ^{28}Si(d,^{3}He)^{27}Al REACTION AND THE STRUCTURE OF ^{28}Si AND ^{27}Al. Wildenthal, B. H.; Newman, E. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 167: 1027-34(Mar. 20, 1968). (ORNL-P-3479).

The level structure of ^{27}Al from 0- to 6.5-MeV excitation was studied with the ^{28}Si(d,^{3}He)^{27}Al reaction at $E_d = 34.4$ MeV. Eight experimental angular distributions are presented. Assignments of l values and spectroscopic factors are made with a local, zero-range distorted-wave Born-approximation analysis. The deduced l values are consistent with the known spins of levels of ^{27}Al of excitation energy ≤3.0 MeV. Levels at 4.05- and 5.15-MeV excitation are assigned $l = 1$, and the level at 4.40-MeV excitation is assigned $l = 2$. The extracted spectroscopic factors are discussed in terms of some simple models for ^{27}Al and are compared with results from new shell-model calculations. (auth)

18173 STRUCTURE OF NUCLEI WITH NEUTRON EXCESS: ^{47}Ca AND ^{47}K. Sartoris, G.; Zamick, L. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., 167: 1035-43(Mar. 20, 1968).

A shell-model calculation of the low-lying states of ^{47}Ca and ^{47}K was performed employing interaction matrix elements derived from the Hamada–Johnston potential. The configurations of ^{47}Ca and ^{47}K were limited to one-hole states and two-hole, one-particle states relative to a ^{48}Ca core. The change in the single-particle energies in going from ^{40}Ca to ^{48}Ca is discussed. These changes were calculated by a first-order perturbation method using the Hamada–Johnston matrix elements. Of interest in ^{47}K is the fact that the ground state has spin and parity $1/2^+$, whereas the corresponding value is $3/2^+$ for the other potassium isotopes. The positive-parity states of ^{47}Ca lie at surprisingly low excitation energy, and their structure is of particular interest. The spectrum of the negative-parity states of ^{47}Ca was also calculated, as well as spectroscopic factors for single-nucleon transfer reactions. Good agreement with experiment was obtained for the negative-parity states, but the results for the positive-parity states were not entirely satisfactory. (auth)

18174 PROTON HOLE STATES IN ^{29}Al, ^{31}P, AND ^{33}P. Bearse, R. C.; Youngblood, D. H.; Yntema, J. L. (Argonne National Lab., Ill.). Phys. Rev., 167: 1043-8(Mar. 20, 1968).

The low-lying states in ^{29}Al, ^{31}P, and ^{33}P were studied via the reactions ^{30}Si(d,^{3}He)^{29}Al, ^{26}Mg(α,p)^{29}Al, ^{32}S(d,^{3}He)^{31}P, ^{34}S(d,^{3}He)^{33}P, and ^{30}Si(α,p)^{33}P. Spectroscopic factors were extracted for the (d, ^{3}He) reactions leading to two final states in ^{29}Al, three in ^{31}P, and two in ^{33}P. In the ^{30}Si(d,^{3}He)^{29}Al reaction, $l = 2$ and $l = 0$ angular distributions from reactions leading to the ground state and first excited state, respectively, were observed. For the ^{34}S(d,^{3}He)^{33}P reaction, an $l = 0$ distribution for the reaction to the ground state and an $l = 2$ distribution for the reaction to the second excited state were obtained. (auth)

18175 ISOMER RATIOS IN ^{58}Co FROM THE PHOTONUCLEAR REACTIONS (γ,n) AND (γ,np). Rhoades, Clifford E. Jr.; Medicus, H. A. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 167: 1049-52(Mar. 20, 1968).

Isomer ratios in ^{58}Co were measured for the photonuclear reactions ^{59}Co(γ,n)^{58}Co and ^{60}Ni(γ,np)^{58}Co. Their values [(ground-state yield)/(total yield)] are 0.43 ± 0.03 and 0.68 ± 0.03, respectively. Using the Huizenga-Vandenbosch formalism, a spin cutoff parameter $\sigma = 4.4 \pm 0.6$ can be deduced if it is assumed that all the outgoing nucleons are evaporated. If direct processes are included, the spin cutoff parameter determined from the (γ,n) reaction will remain unchanged, whereas the one determined from the (γ,np) reaction will increase somewhat. (auth)

18176 OPTICAL-MODEL ANALYSIS OF THE ^{32}S(α,α)^{32}S ELASTIC SCATTERING FROM 10.0 TO 17.5 MeV. Aldridge, J. P.; Crawford, G. E.; Davis, R. H. (Florida State Univ., Tallahassee). Phys. Rev., 167: 1053-61(Mar. 20, 1968).

Angular distributions for the elastic scattering of α particles by ^{32}S measured at 100-keV intervals in the bombarding energy range from 10.0 to 17.5 MeV were analyzed using a two-parameter optical-model description. Real and imaginary potential-well-depth parameters obtained from this analysis oscillate about their respective mean values as the energy is varied. These mean values are interpreted as the potential parameters uncorrected for compound-system resonance effects. Three phase-equivalent real well depths are determined in the analysis: 103, 132, and 163 MeV. The observed rapid variation of the parameters with energy is consistent with a model proposed by Robson, in which compound-system resonances produce an oscillation of optical-model well-depth parameters about mean values which determine the complex potential scattering. (auth)

18177 NUCLEAR MAGNETIC MOMENT OF ^{85}Rb: RESOLVING A DISCREPANCY. Ehlers, Vernon J.; Fowler, Thomas R.; Shugart, Howard A. (Univ. of California, Berkeley). Phys. Rev., 167: 1062-4(Mar. 20, 1968).

The ratio of the nuclear g_I factor to the atomic g_J factor in ^{85}Rb was measured by the atomic-beam magnetic-resonance technique to be $g_I(\text{uncorr})/g_J = -1.466478\,(22) \times 10^{-4}$. This result is in excellent agreement with recent optical-pumping measurements but is lower than a previously reported atomic-beam result. (auth)

18178 ATOMIC MASSES OF ^{56}Fe AND ^{57}Fe. Hudson, Marshall C.; Johnson, Walter H. Jr. (Univ. of Minnesota, Minneapolis). Contract Nonr-710(58). Phys. Rev., 167: 1064-6(Mar. 20, 1968).

The 16-in. double-focusing mass spectrometer was employed to remeasure the atomic masses of ^{56}Fe and ^{57}Fe in order to study a disagreement between earlier mass-spectroscopic results and nuclear reaction Q-values. It is found that the present results agree well with the nuclear reaction Q-values. A test of the Einstein mass-energy relation was made using the measured ^{57}Fe$-^{56}$Fe isotopic difference and the ^{56}Fe(d,p)^{57}Fe reaction Q-value. The mass-energy relation was substantiated to an accuracy of 0.12%. (auth)

18179 1.528- AND 0.891-MeV STATES OF ^{22}Na. Pronko, J. G.; Rolfs, C.; Maier, H. J. (Univ., Freiburg i. B.). Phys. Rev., 167: 1066-9(Mar. 20, 1968).

The 1.528- and 0.891-MeV states of ^{22}Na were studied using the ^{19}F(α,nγ)^{22}Na reaction at a beam energy of $E_\alpha = 5.1$ MeV. γ-ray angular correlations with the neutrons detected at 0° yielded spin assignments of J = 5 (or 3) and J = 4, respectively. Through the use of Doppler-shift attenuation measurements, the lifetimes of these states were found to be 3.9 psec and 11.1 psec, respectively. (auth)

18180 ACTIVATION CROSS SECTIONS OF CALCIUM, POTASSIUM, AND ALUMINUM FOR 14.2-MeV NEUTRONS. Tiwari, P. N.; Kondaiah, E. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 167: 1091-3(Mar. 20, 1968).

The cross sections for some (n,t), (n,d), (n,p), (n,α), and (n,2n) reactions were measured on the various enriched isotopes of calcium and spectroscopically pure potassium and aluminum. Powdered samples, wrapped in thin aluminum foils to act as neutron monitors, were irradiated with 14.2 ± 0.2-MeV neutrons. The induced absolute activities were measured by a calibrated and specially shielded well-type NaI(Tl) crystal. The following results (in millibarns) for the cross sections were obtained: ^{27}Al(n,p)^{27}Mg, 71 ± 9; ^{40}Ca(n,t)^{38}K (ground state), 0.18 ± .02; ^{42}Ca(n,p)^{42}K, 190 ± 24; ^{43}Ca(n,p)^{43}K, 93 ± 12; ^{43}Ca(n,d)^{42}K, 1.3; ^{44}Ca(n,p)^{44}K, 20 ± 8; ^{44}Ca(n,α)^{41}Ar, 35 ± 3; ^{44}Ca(n,d)^{43}K, 2.6 ± .4; ^{48}Ca(n,2n)^{47}Ca, 900 ± 108; ^{39}K(n,2n)^{38}K (ground state), 2.6 ± .4; ^{41}K(n,p)^{41}Ar, 50 ± 6; ^{41}K(n,α)^{38}Cl, 46 ± 6. The cross sections for the ^{43}Ca(n,d)^{42}K and ^{44}Ca(n,d)^{43}K reactions are reported for the first time. Other cross sections measured in this work are compared with their earlier values. (auth)

18181 ENERGY LEVELS IN ^{39}Ar OBSERVED FROM A STUDY OF THE ^{41}K(d,α)^{39}Ar REACTION AT 7.5-MeV BOMBARDING ENERGY. Graue, Arnfinn; Herland, Lars (Univ. of Bergen). Phys. Norv., 2: 137-40(1967).

The energy-level scheme of ^{39}Ar was measured up to 5.0-MeV excitation energy. Thirty-six levels in ^{39}Ar were observed in an investigation of the ^{41}K(d,α)^{39}Ar reaction using 7.5-MeV deuterons. The alpha particles were recorded in a broad-range multiple-gap spectrograph. The ground-state Q-value for the ^{41}K(d,α)^{39}Ar reaction was measured to be $Q_0 = 8.397 \pm 0.015$. (auth) (Norway)

18182 INELASTIC NEUTRON SCATTERING CROSS SECTIONS OF ^{63}Cu AND ^{65}Cu IN THE ENERGY REGION 0.7 TO 1.4 MeV. Holmqvist, B.; Wiedling, T. (Aktiebolaget Atomenergi, Stockholm). Ark. Fys., 35: 71-83(1968).

The gamma-ray spectra from the ^{63}Cu(n,n$'\gamma$) and ^{65}Cu(n,n$'\gamma$) reactions were studied for seven neutron energies in the energy range 0.7 to 1.4 MeV using a NaI(Tl) scintillation spectrometer and time-of-flight techniques. Scatterers of natural copper were used. Experimental excitation curves were obtained for the two lowest excited levels in the ^{63}Cu and ^{65}Cu isotopes. The experimental (n,n$'$) cross sections for the levels at 668 and 961 keV in ^{63}Cu and 764 and 1114 keV in ^{65}Cu were compared to a modified Hauser-Feshbach theory for inelastic neutron scattering. (auth) (Sweden)

18183 AN INVESTIGATION OF THE GAMMA-RAY DECAY FROM TWO RESONANCES IN THE REACTION ^{54}Fe(p,γ)^{55}Co. Erlandsson, B. (Univ. of Lund, Sweden). Ark. Fys., 34: 263-83(1967).

Iron-54 was bombarded with protons, and 27 peaks in the yield curve for the reaction ^{54}Fe(p,γ)^{55}Co observed in the range of proton energy from 1070 to 2030 keV are reported. Gamma-ray measurements were performed with a lithium-drifted germanium detector, and the decay scheme was studied by a coincidence spectrometer. With the aid of angular distribution measurements, spin assignments are given to the two proton capture states and to some of the low-lying levels in the ^{55}Co nucleus. (auth) (Sweden)

18184 AN INVESTIGATION OF THE GAMMA-RAY DECAY FROM FIVE RESONANCES IN THE ^{50}Cr(p,γ)^{51}Mn REACTION. Wall, N.; Erlandsson, B. (Univ. of Lund, Sweden). Ark. Fys., 33: 325-59(1967).

The ^{50}Cr(p,γ)^{51}Mn reaction was investigated in the energy region $E_p = 1050$ to 1970 keV. The resonance energies and the corresponding ^{51}Mn excitation energies of 46 resonances assigned to this reaction are reported. The Q-value, the excitation energies of bound states, and the gamma-ray intensities at five resonances were determined from measurements of single and coincidence gamma-ray spectra. A level and decay scheme is given. On the basis of the Q-value, a new mass value of ^{51}Mn was calculated. (auth) (Sweden)

18185 ANGULAR DISTRIBUTIONS OF GAMMA-RAYS FROM FOUR RESONANCES IN THE ^{50}Cr(p,γ)^{51}Mn REACTION. Erlandsson, B. (Univ. of Lund, Sweden). Ark. Fys., 34: 285-94(1967).

The angular distribution of some of the strongest gamma-ray transitions from four resonances in the ^{50}Cr(p,γ)^{51}Mn reaction were investigated using a lithium-drifted germanium detector. Spin and parity values were given to the proton capture state and to some of the low-lying levels. (auth) (Sweden)

18186 AN INVESTIGATION OF THE LOW-LYING LEVELS IN ^{45}Sc. Erlandsson, B. (Univ. of Lund, Sweden). Ark. Fys., 34: 293-306(1967).

A target of ^{44}Ca was bombarded with protons. The gamma rays emitted by the 1652-keV resonance were studied, and the decay scheme of this level was investigated with a lithium-drifted germanium detector. With the aid of angular distribution measurements, spin and parity assignments were given to some of the low-lying levels in the ^{45}Sc nucleus. (auth) (Sweden)

18187 THE ANGULAR DISTRIBUTION OF GAMMA RAYS FOLLOWING (α,n) AND (p,n) REACTIONS. Birstein, L.; Chechik, R.; Drory, Ch.; Friedman, E.; Jaffe, A. A.; Wolf, A. (Hebrew Univ., Jerusalem). Phys. Lett., 26B: 220-2(Jan. 22, 1968).

The angular distribution of gamma rays excited by both the (p,n) and (α,n) reactions leading to the final nuclei ^{63}Zn and ^{66}Ga were measured. The results were compared with the compound-nucleus statistical model and it is found that the correct spin for the 190-keV level of ^{63}Zn is uniquely determined; that the (p,n) and (α,n) reactions yield identical values for the multipole mixing ratios; and that the variation of the gamma-ray angular distributions with incident energy, following the (p,n) reaction, is correctly predicted by the model. (auth)

18188 TOTAL REACTION CROSS SECTIONS FOR 29 MeV ^{3}He PARTICLES. Balcarcel, R.; Griffith, J. A. R. (Univ. of Birmingham, Eng.). Phys. Lett., 26B: 213-14(Jan. 22, 1968).

The total reaction cross sections of Mg, Al, Fe, Ni, Cu, and Ag for 29-MeV ^{3}He particles were measured. The results are compared with the nuclear optical model and a simple geometrical model. (auth)

18189 A STUDY OF THE ^{40}Ca(d,d)^{40}Ca, ^{40}Ca(d,p)^{41}Ca AND ^{40}Ca(d,n)^{41}Sc REACTIONS IN THE ENERGY REGION FROM 5.0 TO 6.5 MeV. Leighton, H. G.; Roy, G.; Gurd, D. P.; Grandy, T. B. (Univ. of Alberta, Edmonton). Nucl. Phys., A109: 218-30(1968).

The absolute cross section for the elastic scattering of deuterons from Ca was measured for incident deuteron energies of 5.0, 6.0, and 6.5 MeV. Using the parameters obtained from optical-model analyses of these distributions, the success of distorted-wave Born approximation calculations in predicting the (d,p) and (d,n) stripping distributions in this energy region was evaluated. Fair agreement was obtained to the (d,p) distributions; however, the predictions for the (d,n) distributions were less satisfactory. It was possible to reject certain families of deuteron parameters on the basis of completely unacceptable fits to the (d,n) distributions. (auth)

18190 THE ^{20}Ne(α,γ)^{24}Mg REACTION FROM 3 TO 6 MeV. Highland, G. J.; Thwaites, T. T. (Pennsylvania State Univ., University Park). Nucl. Phys., A109: 163-76(1968).

The ^{20}Ne(α,γ)^{24}Mg reaction was studied from 3 to 6 MeV alpha energy using embedded targets. A total of 19 previously unreported resonances was detected. In many cases the angular distribution of the capture gamma rays was measured, and the main features of the decay scheme are established. Several spin and parity assignments can be made to the resonance states and others are suggested. Corresponding resonances in other reactions are suggested for 15 of the new resonances. One (or possibly both) of the resonances at 5.720 and 5.743 MeV and the resonance at 5.796 MeV might correspond to the 6^+ and 5^- states observed in the ^{12}C(^{16}O,α)^{24}Mg reaction. (auth)

18191 ISOBARIC-ANALOG RESONANCES IN THE REACTIONS ^{55}Mn(p,γ)^{56}Fe AND ^{55}Mn(p,n)^{55}Fe. Otto, G.; Mehnert, R.; Tomaselli, G. (Karl-Marx-Univ., Leipzig). Nucl. Phys., A109: 118-28(1968). (In German).

The excitation curves of the reactions ^{55}Mn(p,γ)^{56}Fe and ^{55}Mn (p,n)^{55}Fe in the energy range from 1300 to 1850 keV show eight asymmetrical resonances with fine structures. The resonances are interpreted as isobaric analog resonances corresponding to the low-lying states of ^{56}Mn and are compared with results of (d,p) experiments. The shapes of corresponding resonances of the (p,γ) and (p,n) reaction are different in some cases, and they are fitted with a formula given by Robson. (auth)

18192 INVESTIGATION OF SOME NEUTRON SCATTERING AND TOTAL CROSS SECTIONS IN THE RESONANCE REGION. Ribon, R.; Cauvin, B.; Derrien, H.; Michaudon, A.; Silver, E.; Trochon, J. (CEN, Saclay, France). pp 119-27 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, '1967. (In French).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

Some recent work on nonfissionable elements (sodium, xenon, gadolinium) is presented. Xenon and gadolinium were studied to determine the spin of a sufficient number of resonances to enable the strength functions for each spin state to be obtained. For xenon, the optimum resolution was 1.5 ns/m at 900 eV (in transmission) and 45 ns/m at 100 eV (in scattering). Several samples of varying thickness were used, the thickest being 100 g of XeF_2. Gadolinium was studied earlier in transmission. The scattering measurements, made with the same resolution as for Xe, are difficult to interpret owing to the large number of resonances due to different isotopes. To improve the results, the separated isotopes were used: a sample containing 2 g of ^{155}Gd enriched to 94% and another containing 2 g of ^{157}Gd, also enriched to 94%. These isotopic assignments, in the case of the Gd and Xe in transmission, were made using a short flight path (17 m) and small sample surfaces (1 to 2 cm^2). Sodium was studied up to several hundred keV in order to detect very small resonances, one of which—at 35 keV—had been found earlier by an activation method. The resolution was of the order of 0.25 ns/m and the thickness of the sample was 17 g/cm^2. Some resonance parameters are presented and the statistical distributions of these parameters are discussed. (auth)

18193 LOW-ENERGY NEUTRON CROSS SECTIONS OF SODIUM. Moxon, M. C.; Pattenden, N. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 129-36 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

The Harwell 45-MeV electron linear accelerator pulsed-neutron source was used to measure the total and capture cross sections of sodium over the energy range from 200 eV to 100 keV. Flight paths of 94 and 32 m were used for the total and capture measurements, respectively, giving best resolutions of 2.6 and 10 nA/m, respectively. Samples of pure sodium metal and sodium chloride solution in heavy water were used in the measurements, having thicknesses between 0.003 and 0.025 Na atom/b. Shape and area analysis methods were used to obtain parameters of resonances at 2.8 and 54 keV. The radiative capture cross section as a function of energy was obtained from the observed γ-ray yield data by correcting for the neutron capture following multiple scattering in the sample with a Monte Carlo calculation programmed for an IBM-7030 computer. (auth)

18194 MICROSCOPIC NEUTRON SCATTERING CROSS SECTIONS FOR REACTOR DESIGN. Smith, A. B.; Lister, D. (Argonne National Lab., Ill.). pp 399-408 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

The results obtained from a comprehensive experimental study of elastic and inelastic neutron scattering are reported. The incident neutron energy interval was 0.3 to 1.5 MeV and scattering from 50 elements extending from Be to U was investigated. Fast neutron time-of-flight techniques including a multi-angle detector system and fully automated computer control were utilized to achieve a good scattered neutron resolution. Differential elastic and inelastic scattering cross sections were determined at eight or more angles at incident neutron energy intervals of 50 keV or less. The elastic angular distributions are expressed as Legendre expansions of up to six terms. The observed differential inelastic cross-sections are integrated to obtain the respective inelastic excitation cross-sections. The experimental results are compared with optical-model Hauser-Feshbach calculations; and it is shown that interpolations of experimental values, based on the model, are valid. Experimental evidence for intermediate resonance structure, width fluctuation effects, and nuclear deformation is presented. The influence of each on calculation is illustrated. (auth)

18195 CROSS SECTIONS FOR SOME (n,p) REACTIONS NEAR THRESHOLD. Paulsen, A.; Liskien, H. (Central Bureau for Nuclear Measurements, Geel, Belg.). pp 217-24 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

Cross sections for the (n,p) reactions on ^{31}P, ^{32}S, ^{58}Ni, and ^{64}Zn were measured near threshold in about 60-keV intervals compared with earlier measurements. Monoenergetic neutrons in the energy range 1.0 to 2.2 MeV were obtained by means of the T(p,n)^{3}He reaction and a 3-MeV Van de Graaff accelerator. The T(p,n) angular distribution was remeasured at $E_p = 3$ MeV with a recoil-proton telescope. The results are compared with theoretical cross sections after the method of Hauser and Feshbach. The application of these reactions as threshold detectors is discussed. (auth)

18196 ENERGY AND INTENSITY MEASUREMENTS ON THE CONVERSION ELECTRONS FROM THE ^{75}Se $\rightarrow$ ^{75}As DECAY. Jahn, P.; Todt, W.; Dragoun, O. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys., 210: 245-50(1968). (In German).

The energies and intensities of conversion lines of eleven γ transitions in the decay ^{75}Se $\rightarrow$ ^{75}As were measured with the Heidelberg $(\pi/2)\sqrt{13}\beta$ spectrometer. The experimental transition energies agree with the results of crystal diffraction spectrometer measurements; in some cases more precise values were obtained. The measured relative K-electron intensities for five transitions are in agreement with previous experiments. The L group of the 97-keV transition was resolved for the first time, and the multipolarity was determined to be E2 from the L subshell ratios. (auth)

18197 EXPERIMENTAL STUDY OF CHANNELING EFFECTS ON THE (p,n) REACTION YIELD IN A VANADIUM SINGLE CRYSTAL. Poizat, J. C.; Remillieux, J.; Sarazin, A. (Univ., Lyon). Nucl. Instrum. Methods, 59: 272-6(Feb. 1968).

The channelling effects on a (110) plane of vanadium single crystal with 2 MeV protons are investigated by the study of the cross-section of the ^{51}V(p,n)^{51}Cr nuclear reaction. Neutrons are detected by means of a time-of-flight method, and so energy measurements are possible. The channeling effect is correlated to the observation of a minimum in the cross section of the reaction. The attenuation rate is 36% for the reactions occurring near the surface of the crystal. The effect decreases exponentially with the depth where the reaction occurs in the crystal. An attenuation is also observed as a function of the integrated proton flux. This effect is reduced by a factor two when the integrated flux reaches 4×10^{16} protons/mm^2. (auth)

18198 THE USE OF COMPTON-SCATTERED GAMMA RAYS FOR NUCLEAR RESONANCE FLUORESCENCE STUDIES. **Tandon, G. K. (Yale Univ., New Haven); McIntyre, J. A. Nucl. Instrum. Methods, 59: 181-96(Feb. 1968). (YALE-2726-H-94).**

An instrument was developed for exciting nuclear energy levels using a variable energy gamma ray beam. The beam of desired energy is produced by scattering 1.33 MeV gamma rays through the proper scattering angle. By exciting nuclear energy levels through the resonance fluorescence process, the lifetime of the level can be determined. The method was tested by measuring the lifetimes of the 963-keV levels in ^{63}Cu and ^{152}Sm. Agreement was found with previous measurements. An evaluation of the utility of the instrument for measuring lifetimes is given. (auth)

18199 NUCLEAR SPECTROSCOPY WITH ENERGY RESOLUTION OF A PART PER MILLION. **Kapadia, C. J.; Michalk, V. E.; McIntyre, J. A. (Texas A and M Univ., College Station). Nucl. Instrum. Methods, 59: 197-213(Feb. 1968).**

An instrument is described for producing a variable energy gamma ray beam with energy resolution of a part per million utilizing neutron capture gamma rays. The variation in energy is achieved through the recoil velocity of the radiating nucleus which has been excited by a gamma ray through the resonance fluorescence process. The instrument was tested by exciting an energy level at 7.277 MeV in ^{208}Pb, also through the resonance fluorescence process, and it is shown that the line width Γ of the level can be measured. It is estimated that with a one MW reactor (neutron flux of 10^{13}/cm^2 · sec) one energy level per month can be studied using such an instrument. (auth)

18200 THE MICHIGAN STATE UNIVERSITY SIX GAP β-RAY SPECTROMETER AND ITS APPLICATION TO THE β- AND γ-RAY SPECTROSCOPIC STUDIES OF ^{83}Sr AND ^{131m}Te. **Beyer, Louis Martin. Lansing, Mich., Michigan State Univ., 1967. 161p.**

Thesis.

A six gap, iron core β-ray spectrometer was constructed. The instrument, often called the "orange" spectrometer because of its geometric similarity to an orange, is similar to the one described by Bisgard. The spectrometer and its associated components are discussed in detail. A semiquantitative theory of the focusing properties of a 1/5 field is included and the defocusing components of the field that are characteristic of this type of instrument are discussed. The orange spectrometer and the MSU iron free $\pi\sqrt{2}$ spectrometer were used to investigate the internal conversion electron and positron spectra emitted in the decay of ^{83}Sr. Information on the multipolarities of the strongest transitions was obtained. The M2 multipolarity assignment of the 42.3 keV transition, in conjunction with existing coincidence and lifetime measurements, show that the low energy features (≤804.6 keV) of the decay scheme are uniquely determined. These data, when combined with log ft values obtained from a Fermi analysis of the positron spectra, lead to spin-parity assignments (in parentheses) to the ground state of ^{83}Sr($7/2^+$) and to the 5.0 keV($3/2^-$), 42.3 keV($9/2^+$), 99.2 keV ($1/2^-$), 389.2 keV($3/2^-$), 423.5 keV($5/2^+$) and 804.6 keV($7/2^+$) states of ^{83}Rb. The $7/2^+$ assignment to the ground state of ^{83}Sr does not agree with the shell model calculations of Talmi and Unna, although their calculations do predict a low-lying $7/2^+$ state at 320 keV. The level scheme of ^{83}Rb is also discussed with respect to expectations based on shell model systematics. The gamma-ray spectrum of ^{131m}Te was thoroughly investigated with the high resolution Ge(Li) detectors, accurately determining the energies and relative intensities of 45 transitions in the spectrum. The use of the NaI(Tl)-Ge(Li) coincidence technique has resulted in the placement of all but six very weak transitions into a consistent decay scheme. The orange and $\pi\sqrt{2}$ spectrometers have been used to investigate the internal conversion electron spectrum. Conversion coefficients were obtained for the 80.9, 102.3, 149.7, 200.7, 240.6, 334.5, 452.7 and 773.7 keV transitions. Further information on spin-parity assignments was provided by the calculated log ft values which were obtained using gamma-ray intensities. The combined data provide a level scheme for ^{131}I with the following energies (in keV) and spin-parity assignments: 0($7/2^+$), 149.7($5/2^+$) 493($1/2^+$), 603($3/2^+$, $5/2^+$), 773.7($9/2^+$, $11/2^+$), 852.1($9/2^+$, $11/2^+$), 1059.7 ($7/2^+$), 1315($7/2^+$), 1556.4($7/2^+$, $9/2^+$), 1596.5($7/2^+$, $9/2^+$), 1646($9/2$, $11/2$), 1797($9/2^-$, $11/2^-$), 1888, 1899($9/2^-$, $11/2^-$), 1980($9/2^-$, $11/2^-$), 2001, 2168 and 2270. Recent theoretical calculations for the states of ^{131}I have been performed by Kisslinger and Sorensen and by O'Dwyer and Choudhury. Although there are insufficient data available for a quantitative analysis, a qualitative comparison of the data has been made for both sets of calculations. A survey was made of the energy level systematics of the low energy states of all the odd mass iodine isotopes. Of special interest is the observed quadratic behavior of the energies of separation of the $1/2^+$, $3/2^+$ and $5/2^+$ states with respect to the $7/2^+$ state, as a function of the neutron number. (Disser. Abstr.)

18201 NUCLEAR STRUCTURE EFFECTS IN SIMPLE HIGH-ENERGY SPALLATION REACTIONS. **Karol, Paul Jason. New York, Columbia Univ., N. Y., 1967. 97p.**

Thesis.

Cross sections for the (p,pn), (p,p2n), (p,2pn), and (p,2p2n) reactions at 370 MeV with ^{58}Ni and ^{64}Zn were determined in anticipation of finding an explanation for the "anomalously low" ^{58}Ni (p,pn)^{57}Ni cross section of ~30 mb compared to ~60 mb for other medium mass nuclei. All of the cross sections for corresponding reactions were found to be lower with ^{58}Ni than with ^{64}Zn. These results rule out the explanation that the cross section for the ^{58}Ni(p,pn)^{57}Ni reaction is low because of an anomalous excitation-energy spectrum following a (P,PN) knockout. Detailed consideration is given to the roles played by the one-step and the two-step mechanisms and nuclear structure in determining the high-energy (p,pn) cross section. It is concluded that the current theoretical models for simple spallation reactions are able to explain the anomalous (p,pn) cross section provided previously ignored details of nuclear structure are taken into proper account. In the specific case of ^{58}Ni, a small nuclear skin-thickness relative to neighboring nuclei accounts for the low (p,pn) cross section owing to the "surface localization" of the reaction. Evidence is quoted from the literature justifying the plausibility of this thin-skin hypothesis. (Disser. Abstr.)

18202 THE ^{40}Ca(p,p)^{40}Ca REACTION. **Rich, Wiley Foster. Houston, Tex., Rice Univ., 1967. 127p.**

Thesis.

Studies of the elastic scattering of protons from ^{40}Ca were made in the range of proton energies from 5.0 to 12.6 MeV. The investigation consisted in measurements of excitation functions at laboratory angles of 90, 125, 140, and 170° with an experimental resolution (beam dispersion plus target thickness) of about 15 keV, and measurements of angular distributions at approximately 0.5 MeV intervals with an experimental resolution of about 50 keV. The excitation functions show evidence for many resonances, attributable chiefly to s-, p-, d-, and f-wave scattering for proton energies up to ~8.5 MeV. Above this energy, there is a marked attenuation of the resonance amplitudes, and the resonance shapes are generally unrecognizable. The angular distributions have basically similar shapes throughout the energy interval, and are little influenced by the local resonance structure. The angular distribution data are analyzed by the method of complex phase shifts. This analysis revealed evidence for broad anomalies in the $s_{1/2}$-, $p_{3/2}$-, and $d_{5/2}$-wave scattering at proton energies of 8.5, 9.3, and 10.1 MeV respectively, and also provided a description of the continuum cross section, with respect to which dispersion theory fits to the experimental excitation function were calculated. These fits were calculated in the range of proton energies from 5.0 to 7.4 MeV (the data from 5.0 to 6.5 MeV, taken from earlier work, were re-analyzed). These fits were sufficiently good to confirm level assignments for 61 prominent resonances in the data. (Disser. Abstr.)

18203 GAMMA-RADIATION FROM RADIOACTIVE ISOTOPES AND FISSION PRODUCTS (THEORY AND TABLES). **Gusev, N. G.; Mashkovich, V. P.; Obvintsev, G. V. International Monographs Series on Advanced Mathematics and Physics. Delhi, Hindustan Publishing Corp. (India), 1967. 233p.**

Authorized English Translation of the Russian Publication, Gamma-Izluchenie Radioaktivin'x Izotopov i Produktov Deleniya.

Data are given on the gamma radiation emitted by radioactive isotopes and the composite fission products of ^{235}U, which are necessary for various practical applications, especially in the calculation of radiation shielding. The gamma constants are given for about 400 isotopes without any initial absorbers and with Pb absorbers. Gamma activity per mCurie in mg-equivalent of Ra, intensity of bremsstrahlung, specific beta and gamma activity and spectral composition of the gamma radiation of fission products of ^{235}U are given. (S.F.L.)

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Refer also to abstracts 17870, 18123, 18136, 18192, 18194, 18200, 18203, 18307, 18330, 18336, 18339, 18345, 18348, 18349, and 18351.

18204 (BMwF-FBK-67-90) BEITRAEGE ZUR BERECHNUNG DER STREUUNG SCHNELLER NEUTRONEN AN U-238. **(Contributions to the Calculation of the Scattering of Fast Neutrons in ^{238}U). Buehler, F.; Schmidt, F. (Technische Hoch-**

schule, Stuttgart (West Germany). Institut fuer Kernenergetik). Dec. 1967. 82p. (In German). Dep.

The separation of the compound-nucleus cross section σ_c is considered by the theories of Hauser and Feshbach and P. A. Moldauer. For the example ^{238}U two sets of optical-model parameters are given such that the measured values of the total cross section σ_{tot} and the nonelastic cross section σ_x agree well with the values calculated by the optical model in connection with both theories. It is found that only the cross sections of compound elastic scattering σ_{nn} show substantial differences. So for practical uses it seems to be sufficient to predict cross sections of inelastic scattering by the theory of Hauser and Feshbach. It is found that evaluations with the evaporation model agree better with experimental values if σ_c is calculated by the theory of Moldauer. Elastic scattering and inelastic direct processes of fast neutrons on ^{238}U are discussed. For this, a deformed optical potential is used. Its form factors are fixed by generalization of the equivalent local potential of Percy and Buck (1962). A spherical spin-orbit potential is added. The target nucleus is described with the collective model. With the generalized equivalent local potential the coupled system of Schroedinger equations for the radial part of the wave functions is integrated. The cross sections obtained are compared with the DWBA method. The influences of higher rotational states of ^{238}U on the elastic and inelastic scattering are discussed. From Coulomb excitation experiments, the deformation parameter of the potential is estimated. Its definitive value is determined by comparing the theory with experiments. (auth)

18205 (FEI–64) RADIATSIONNYI ZAKHVAT NEITRONOV PRI SINTEZE TYAZHELYKH ELEMENTOV. (Radiative Neutron Capture in the Synthesis of Heavy Nuclei). Shorin, V. S.; Kapchigashev, S. P.; Kolesov, V. E. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1966. 30p. (In Russian). Dep.

The models of S- and r-processes of element formation in the stars are considered. New experimental data from the literature on the radiative neutron capture cross sections for separated isotopes, cross sections calculated from the statistical theory of nuclear reactions, and data on the chemical composition of meteorites have been used to derive the values of $N_s\sigma_{n,\gamma}$ for the nuclei formed in the pure S-process. The results obtained are 2 to 3 times lower than those proposed earlier, and have confirmed a smooth dependence of the function N on the atomic weight. The contribution of the S- and r-processes to the absolute abundance of heavy nuclei formed in the mixed capture (^{86}Sr–^{203}Tl) have been calculated on the basis of the $N_s\sigma_{n,\gamma} = f(A)$ graph. (JPRS)

18206 (IAE–1302) SECHENIE DELENIYA URANA-235 V OBLASTI ENERGII 0,8–170,0 eV. (^{235}U Fission Cross-Section in the Energy Region 0.8 to 170.0 eV). Mostovaya, T. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1967. 19p. (In Russian). Dep.

The fission cross section of ^{235}U in the energy range from 0.8 to 170 eV was measured by the time-of-flight method with a resolution of 19 nsec/m. It is suggested that in order to detect weak levels, further studies should be done at low temperatures to avoid the Doppler expansion effect. (auth)

18207 (JINR–D7-3548) TRUDY MEZHDUNARODNOI KONFERENTSII PO FIZIKE TYAZHELYKH IONOV DUBNA, 13–19 OKTYABRYA 1966 G. VYPUSK 2. SINTEZ I ISSLEDOVANIE SVOISTV IZOTOPOV TRANSURANOVYKH ELEMENTOV. (Report of the International Conference on Physics of Heavy Ions, Dubna, October 13–19, 1966. Volume 2. Synthesis and Investigation of Properties of Isotopes of Transuranic Elements). (Joint Inst. for Nuclear Research, Dubna (USSR)). 70p. (In English and Russian). (CONF-661035). Dep.

Separate abstracts were prepared for four of the eleven papers included. The other seven papers have previously appeared in NSA and may be located by referring to CONF-661035 in the report number index. (D.C.W.)

For abstracts of individual papers see: 18208–18210 and 18307.

18208 (JINR–D7-3548, pp 3-14) SINTEZ I ISSLEDOVANIE SVOISTV IZOTOPOV TRANSURANOVYKH ELEMENTOV. (Synthesis and Investigation of Properties of Isotopes of Transuranium Elements). Flerov, G. N.; Donets, E. D.; Druin, V. A.; Lobanov, Yu. V.; Mikheev, V. L.; Polikanov, S. M.; Shchegolev, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). (In Russian).

A brief review is given of the experimental research carried out at the Joint Institute for Nuclear Research during the period 1963 to 1966. The development of the cyclotron and other auxiliary detection equipment is discussed. Alpha-decay data on isotopes from einsteinium to lawrencium are tabulated. The controversy over the synthesis and identification of element 102 is also discussed. The synthesis and identification of element 104 is described, and it is indicated that the reactions ^{243}Am(^{22}Ne,4n) and ^{243}Am(^{22}Ne,5n) will be used in future attempts to synthesize element 105. (R.V.J.)

18209 (JINR–D7-3548, pp 39–47) CALCULATIONS ON THE PRODUCTION OF THE NEXT CLOSED SHELL NUCLEUS AND OTHER NUCLEI. Friedman, A. M. (Argonne National Lab., Ill.).

Cross sections were calculated for nuclear reactions of the following type: ^{36}Ar + ^{242}Cm → $^{278}_{114}$Z, ^{76}Ge + ^{208}Pb + $^{284}_{114}$Z, ^{84}Kr + ^{184}Pt → $^{278}_{114}$Z, and ^{136}Xe + ^{142}Nd → $^{278}_{114}$Z. These cross sections were calculated by using the usual expression for cross section σ_{cl} for forming a compound nucleus with a given angular momentum l of the incoming particles. However, for low excitation energies σ_{cl} involved below the fission threshold one can not assume that every angular momentum value will populate states with equal probability. Therefore, the cross sections σ_{cl} are multiplied by ρ_l, the density of states of spin I where I equals to 1 in the final nucleus, and $\bar{\Gamma}$ the average level width, since the targets and projectiles are all of spin = 0 and I = 1. The level densities at low excitation energies were also calculated for the nuclei $^{278}_{114}$Z and $^{284}_{114}$Z. The relation between ρ_l and σ_l and the product $\sigma_c\rho_l$ for ^{84}Kr and ^{194}Pt is illustrated; and the total cross sections for the formation of $^{284}_{114}$Z and $^{278}_{114}$Z with the different ions, using an average value of 0.1 eV for $\bar{\Gamma}$, are presented. (B.G.D.)

18210 (JINR–D7-3548, pp 65-70) VLIYANIE PODOBOLOCHKI S CHISLOM NEITRONOV N = 152 NA VELICHINU Γ_n/Γ_f V REAKTSIYAKH S TYAZHELYMI IONAMI. (The Influence of the Subshell with Neutron Number N = 152 on the Magnitude of Γ_n/Γ_f in Reactions with Heavy Ions). Mikheev, V. L.; Polikanov, S. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). (In Russian).

The results are given of measurements of cross sections of formation of five isotopes of element 102 with N = 150 to 154 during irradiation of ^{242}Pu and ^{239}Pu targets by ^{18}O and ^{16}O ions from the cyclotron U-300. Concrete data are tabulated. All experiments were carried out on one installation, the relative accuracy of cross section magnitudes used in experiments on Γ_n/Γ_f was 20 to 30% which leads to the error Γ_n/Γ_f of about 5 to 7%. Experimental data concluded that the influence of the subshell with N = 152 extends up to 15 MeV excitation energy. The data include the sum of two-neutron bond energies, their kinetic energy and γ-quantum energy. (R.V.J.)

18211 (NAA-SR-Memo–12538) INFLUENCE OF NUCLEAR DEFORMATION ON NEUTRON WAVE STRENGTH FUNCTIONS OF HEAVY EVEN–EVEN ROTOR NUCLIDES. Gigas, G. (Atomics International, Canoga Park, Calif.). Oct. 1, 1967. Contract AT-(04-3)-701. 16p. Dep. CFSTI.

The neutron s-, p-, and d-wave strength functions for 15 heavy even-even rotor nuclides from ^{226}Ra to ^{244}Cm were calculated with a deformed nucleus optical model using the deformations of Stelson and Grodzins. Repetition of the analyses with reduced deformations, as suggested by considerations of the multipole moments of diffuse-edged charge distributions and the potential scattering radius data, produced an improved agreement with experimental measurements. The reduced deformations were essentially equivalent to the ground-state equilibrium deformations calculated from the BCS theory using projected wave functions including an explicit Coulomb term. Comparative analyses with a single-particle vibrator model, as well as a spherical nucleus with a diffuse edge, are presented. (auth)

18212 (SGAE-PH–58/1967) PRAEZISIONSMESSUNG KONTINUIERLICHER BETASPEKTREN. (Precision Measurement of Continuous Beta Spectra). Zemann, H.; Semrad, D. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). 1967. 14p. (In German). Dep.

Instrumental effects that occur in measuring continuous beta spectra by means of a Siegbahn–Slätis intermediate-image spectrometer are discussed. Corrections or upper limits for these effects are given. The results are applied to the measurement of the ^{114}In and ^{32}P spectra, and it is found that both agree with the statistical shape. (auth)

18213 (SGAE-PH-59/1967) UNTERSUCHUNG DER PROMPTEN γ-STRAHLUNG DER SPALTFRAGMENTE BEI DER SPONTANEN SPALTUNG VON Cf-252. (Investigation of the Prompt γ Rays of the Fission Fragments on Spontaneous Fission of ^{252}Cf). Axmann, H. P.; Ujlaki, E. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). 1967. 11p. (In German). Dep.

A Ge(Li) detector was used for the analysis of the low-energy prompt γ radiation (100 to 300 keV) of the fragments originating from the spontaneous fission of ^{252}Cf. The fission-fragment spectra were detected by means of Si(Au) surface-barrier detectors. The fission-fragment pulses gated the spectrum recorded in the γ-ray detector. Measurements in two different geometries produced very well structured γ spectra and permitted a rough estimation of the emission time of particular γ lines. (auth)

18214 (BNL-tr-187) CORRELATIONS OF THE RESONANCE PARAMETERS OF FISSIONABLE NUCLEI. Gai, E. V.; Rabotnov, N. S. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report FEI-56. 11p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The bases for the appearance of correlations between the various random variables that characterize neutron resonances are discussed. It is shown that if the correlation coefficient of two random variables is known, the difference between the average resonance parameters for the two spin subsystems can be assessed. (D.C.W.)

18215 (BNL-tr-192) EFFECTIVE MOMENTS OF INERTIA OF HEAVY NUCLEI AT THE SADDLE POINT. Karamyan, S. A.; (and others). Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz., 6: 494-504 (1967). 24p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

The angular distributions of fission fragments were investigated by irradiating targets of ^{197}Au, ^{209}Bi, and ^{238}U with accelerated ^{12}C, ^{14}N, ^{16}O, and ^{22}Ne ions with energies of 6 to 8 MeV/nucleon. The angular dependence of the elastic scattering cross section was measured for every combination of target and particle and for every energy of bombarding ions. The partial cross sections of compound-nucleus production were determined from the elastic scattering data. Using these cross sections, the effective moments of inertia of nuclei with Z^2/A from 35 to 40 were calculated on the basis of the statistical model. It is shown that the quantity J_{eff} within the accuracy of the experiment depends only upon Z^2/A and is independent of the nuclear temperature. $(Z^2/A)_{crit}$, which was obtained from the extrapolation of experimental data, lies within 45 to 47. (auth)

18216 TOTAL NEUTRON CROSS SECTION OF ORIENTED ^{165}Ho FROM 2 TO 135 MeV. Marshak, H. (National Bureau of Standards, Washington, D. C.); Langsford, A.; Wong, C. Y.; Tamura, T. Phys. Rev. Lett., 20: 554-8(Mar. 11, 1968).

The effect of nuclear orientation on the total neutron cross section of the highly deformed ^{165}Ho nucleus was measured from 2 to 135 MeV. The data are successfully fitted by adiabatic coupled-channel calculations. The origin of this effect can also be understood by a semiempirical model which makes use of both the black-nucleus model and the nuclear Ramsauer effect. (auth)

18217 DECAY OF SHORT-LIVED MEMBERS OF THE MASS-115 CHAIN. Kjelberg, A.; Pappas, A. C.; Tunaal, T. (Univ. of Oslo). J. Inorg. Nucl. Chem., 30: 337-44(Feb. 1968).

Radiochemical methods were developed for fast separation of silver and cadmium from palladium and of cadmium from silver, all produced in fission. Half-lives of 36 ± 3 sec for ^{115}Pd and of 49 ± 6 sec for ^{115m}Ag were determined as well as a 29 ± 2% branching from ^{115}Pd via ^{115m}Ag to 2.3-day ^{115g}Cd. No evidence was found for isomeric transition in ^{115}Ag (and in ^{113}Ag). There were indications for a beta branch from ^{115m}Ag to ^{115m}Cd. (auth) (UK)

18218 RELATIVE INDEPENDENT YIELDS FOR ^{95}Nb AND ^{95m}Nb FROM LOW-ENERGY FISSION. Rudy, C.; Vandenbosch, R.; Ratcliffe, C. T. (Univ. of Washington, Seattle). J. Inorg. Nucl. Chem., 30: 365-8(Feb. 1968).

The isomeric cross-section ratio $\sigma(I = 9/2)/[\sigma(I = 9/2) + \sigma(I = 1/2)]$ for the independent production of ^{95}Nb and ^{95m}Nb from 10-MeV proton-induced fission of ^{235}U was determined to be 0.96. The favoring of the high-spin isomer is to be contrasted with a recent report (Hagebo, J. Inorg. Nucl. Chem. 25: 1201(1963)) that the low-spin isomer is strongly favored in low-energy fission of ^{238}U, but is consistent with expectations based on previously reported isomer ratios for other isomeric pairs. (auth) (UK)

18219 INVESTIGATION OF THE ^{145}Eu EMISSIONS. Adam, I.; Vilskii, K.; Zhelev, Zh.; Jorgensen, M.; Krivopustov, M.; Kuznetsov, V.; Nilsen, O. B.; Finger, M. (Nils Bohr Inst., USSR. Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 122-32(Jan. 1967). (In Russian).

The conversion electron and γ-spectra of ^{145}Eu, and eγ and $\beta^+\gamma$ coincidence of ^{145}Eu and ^{147}Eu were studied to obtain fuller and more precise data on the ^{145}Sm nucleus. It was found that all the observable transitions above 1870 keV are direct transitions into the ^{145}Sm ground state. The quantum characteristics were assigned to a number of energy levels between 1005.2 and 1997.2 keV on the basis of experimentally determined conversion coefficients and log ft values. (JPRS)

18220 ON THE PROBABILITY OF THE $5/2^-$ [532] → $3/2^+$ [411] TRANSITIONS IN ^{159}Tb, ^{157}Tb, ^{155}Tb, AND ^{155}Eu NUCLEI. Kokesh, A.; Zvolski, I. (Nuclear Research Inst., Czechoslovak Academy of Sciences, Rez). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 133-45 (Jan. 1967). (In Russian).

The γ-transitions $5/2^-$ [532] → $3/2^+$ [411] in ^{155}Tb, ^{159}Tb, ^{157}Tb and ^{155}Eu were studied by half-life measurements using ^{159}Gd, ^{157}Dy, ^{155}Dy, and ^{155}Sm and the fast-slow coincidence method. The probability and delay factor values for the transitions are given. The observed reduced transition probability ratios for ^{157}Tb and ^{159}Tb are close to the theoretical when Coriolis forces are taken into account. (JPRS)

18221 THE α-SPECTRUM FINE STRUCTURE IN THE RARE EARTH REGION. Chumin, V. G.; Zhelev, Zh. T.; Gromov, K. Ya.; Makhmudov, B. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 146-50(Jan. 1967). (In Russian).

A precision magnetic α-spectrograph made possible by the earlier development of preparation of neutron-deficient rare earth isotopes was used to study the α-spectra of ^{151}Tb, ^{150}Tb, and ^{149}Tb in the range 3070 to 3980 keV. Two new low intensity α-lines at approximately 3183 and 3492 keV were discovered, and the corresponding half-life energies and periods calculated. (JPRS)

18222 ENERGY MEASUREMENTS OF THE MAIN ^{225}Ac α-GROUPS. Dzhelepov, B. S.; Ivanov, R. B.; Moskvin, L. N.; Rodionov, V. F. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 151-3 (Jan. 1967). (In Russian).

In view of the existing literature discrepancies, a more accurate measurement of the α-group energies in the Ac spectrum was undertaken using an α-spectrometer with α-particle focussing at an angle $\pi\sqrt{2}$ by comparison with α-group energies of ^{244}Cm, ^{238}Pu, ^{239}Pu, and ^{240}Pu. A value of 5830 ± 5 keV was obtained. (JPRS)

18223 INVESTIGATION OF ^{152}Tb RADIATION. Gromov, K. Ya.; Kuznetsov, V. V.; Kuznetsova, M. Ya.; Finger, M.; Urbanets, Ya.; Nil'sen, O. B.; Vil'skii, K.; Skilbrait, O.; Jorgensen, M. (Neils Bohr Inst., USSR. Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 154-70(Jan. 1967). (In Russian).

The ^{152}Tb → ^{152}Gd γ-ray spectrum was studied using Ge semiconductor detectors and e γ and $\beta^+\gamma$ coincidence with the aid of a toroidal β spectrometer and scintillation spectrometer, and the conversion electrons with the ρ spectrometer and a magnetic γ spectrometer. It is concluded that the 1318.0 keV (2^+) level excited in ^{152}Tb decay and the 1315.0 keV (1^-) level excited in ^{152}Eu decay are not identical. A comparison of the reduced transition probability ratios for the same ^{152}Gd and ^{150}Sm levels indicates similar properties, and that at the lower levels the former are generally lower than the corresponding levels of the latter. (JPRS)

18224 POSITRONS EMITTED IN THE DECAY OF ^{172}Hf + ^{172}Lu. Dzhelepov, B. S.; Dolgoborodova, M. A. Vestn. Leningrad. Univ., No. 16, Ser. Fiz. Khim., No. 3, 58-64(Aug. 1967). (In Russian).

The number of positrons from the decay of ^{172}Hf + ^{172}Lu was investigated by means of γ-γ coincidence scintillation spectrometry. The upper limit of the number of positrons in the decay of ^{172*}Lu and ^{172}Lu was established to be 15×10^{-5} and 14×10^{-5} positrons per disintegration, respectively. Thus, for the decay of ^{172*}Lu to 0^+ and 2^+ states of ^{172}Yb and for the decay of ^{172}Lu to the 0^+ state of ^{172}Yb, the log-ft values were log ft > 7.6 and log ft > 10.7, respectively. (auth)

18225 NEUTRON RESONANCE SPECTROSCOPY. VI. Mo, Sb, Te, AND Pr. Wynchank, S.; Garg, J. B.; Havens, W. W. Jr.; Rainwater, J. (Columbia Univ., N. Y.). Phys. Rev., 166: 1234-(Feb. 20, 1968).

The total neutron cross sections of natural Mo, Te, Sb, and Pr were measured from about 6 eV to a maximum energy of 250 keV for Mo and Pr and to about 5 keV for Sb and Te, using the Nevis synchrocyclotron and a 200-m flight path. The maximum time resolution is 0.5 nsec/m. The resonance energies and the neutron reduced widths of about 1000 levels were obtained, using area analysis. Values of $\Gamma_\gamma \sim 100$ MeV were obtained for the capture widths of 15 levels in natural Sb. Values of the spin J of the compound nucleus were obtained for a number of levels of Pr. Values for the s-wave strength function for Mo, Sb, Te, and Pr are S_0 = (0.35 ± 0.06), (0.34 ± 0.05), (0.15 ± 0.03), and (1.72 ± 0.25) × 10^{-4}, respectively. An average level spacing $\langle D \rangle$ = 75.2 eV was obtained for Pr. The presence of many p-wave levels led to a strong energy dependence of the observed $\langle D \rangle$ = for Mo, Sb, and Te. The observed statistical distributions of the neutron reduced widths and nearest-neighbor level spacings for Pr and natural Sb are compared with the Porter–Thomas and Wigner distributions, respectively. (auth)

18226 NEUTRON-INDUCED FISSION CROSS SECTION OF ^{242m}Am. Bowman, C. D.; Auchampaugh, G. F.; Fultz, S. C.; Hoff, R. W. (Univ. of California, Livermore). Phys. Rev., 166: 1219-26(Feb. 20, 1968).

The neutron-induced fission cross section of ^{242m}Am was measured from 0.02 eV to 6 MeV by the time-of-flight method at the Livermore 30-MeV linear electron accelerator. The data are normalized at 0.0253 eV to a value of 6600 b measured in a reactor thermal-neutron flux. The cross section at 0.2 eV is 4700 b; at 1 eV it is 540 b; and at 4 MeV it is 2.1 b. The data are analyzed to obtain values for the neutron strength function $\langle\Gamma_n^0/D\rangle$ of 1.4×10^{-4}, the level spacing $D = 1.2$ eV, and the quantity $2\pi\langle\Gamma_f/D\rangle = 2.5$. All three quantities are quoted per spin state. The high cross section at low energies can be attributed to the unusually high value for $2\pi\langle\Gamma_f/D\rangle$, and to the existence of a very large resonance at 0.173 eV. The fission cross section of ^{241}Am also was measured in the MeV region and found to be 1.96 ± 0.2 b at 2.5 MeV. (auth)

18227 DECAY SCHEME OF ^{158}Tb. Schroeer, D.; Jastram, P. S. (Ohio State Univ., Columbus). Phys. Rev., 166: 1212-18(Feb. 20, 1968).

A study was made of the decay of ^{158}Tb, including measurements of transition intensities, lifetimes of excited states, and angular correlations. The resulting decay scheme is generally in agreement with that proposed in previous studies. Major modifications include a new level at 819 keV in ^{158}Dy, and several new γ-ray transitions which were seen in coincidence studies and which may be due to a long-lived isomeric state in ^{158}Tb. Also, improvement was attained in the precision of the intensities of several weak γ-ray transitions, and of the β-branching ratio. The lifetimes of the first 2^+ states in ^{158}Gd and ^{158}Dy were redetermined for several different cascades through $\beta-\gamma$ as well as $\gamma-\gamma$ coincidence-delay studies; the values measured were, respectively 2.59 ± 0.10 and 1.76 ± 0.10 nsec. The 1188-keV state and the 1107-keV γ-ray transition in the decay to ^{158}Gd were confirmed to be, respectively, a 2^+ state and an E2 transition through an angular-correlation measurement. These modifications and improvements in the decay scheme are discussed on the basis of the rotational model of deformed nuclei. (auth)

18228 ENERGY LEVELS OF ^{135}La. Abdul-Malek, A.; Naumann, R. A. (Princeton Univ., N. J.). Phys. Rev., 166: 1194-1205(Feb. 20, 1968).

The energy-level structure of ^{135}La was investigated through the decay of ^{135}Ce. Conversion-electron and γ spectra were studied using magnetic, scintillation, and solid-state spectrometers. Various $\gamma-\gamma$ and electron-γ coincidence experiments were conducted. A revised level scheme is proposed for ^{135}La incorporating a number of new transitions. Spin and parity assignments are discussed. (auth)

18229 K X RAYS FROM ^{252}Cf FISSION FRAGMENTS IN TERNARY FISSION. Kapoor, S. S.; Ramamurthy, V. S.; Rao, P. N. Rama (Bhabha Atomic Research Center, Bombay). Phys. Rev., 166: 1190-3(Feb. 20, 1968).

The yield and the energy distribution of the K x rays emitted by ^{252}Cf fission fragments were simultaneously measured for the cases of ternary and binary fission, with a cooled lithium-drifted silicon detector. The K x-ray yields in ternary fission are found to be greater than in binary fission by (25 ± 6) and (14 ± 6)% for fragments in the light and the heavy groups, respectively. It has been shown that a comparison of K x-ray yields and the energy spectra in binary and ternary fission can give information about the origin of the light charged particles emitted in ternary fission. From the analysis of the present results, it is inferred that these charged particles do not originate at the expense of nucleons exclusively from either of the fragment groups, but are liberated from the fissioning nucleus as a whole, implying emission just before or at the instant of scission. (auth)

18230 RESONANCE ANALYSIS OF THE ^{233}U FISSION CROSS SECTION. Bergen, D. W.; Silbert, M. G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 166: 1178-89(Feb. 20, 1968). (LA-DC-8946).

The neutron-induced fission and capture sections of ^{233}U were measured by time of flight with a nuclear detonation as the neutron source. Cross-section data are presented from 20 to 10^6 eV for fission and from 30 to 63 eV for the capture-to-fission ratio α. Data in the resonance region (20 to 63 eV) were fitted both by a single-level function consisting of a sum of Briet-Wigner levels and by the Reich-More multilevel function based on R-matrix theory. The resulting resonance parameters are listed and discussed. A study of cross sections derived from two and three hypothetical resonances under various conditions of interference is presented to determine the validity of the resonance parameters derived from the multilevel fit. (auth)

18231 (d,^{3}He) REACTIONS ON THE EVEN ZIRCONIUM ISOTOPES. Preedom, B. M. (Oak Ridge National Lab., Tenn.); Newman, E.; Hiebert, J. C. Phys. Rev., 166: 1156-66(Feb. 20, 1968). (ORNL-P-3522).

An investigation of the proton ground-state configurations in the even zirconium isotopes (A = 90, 92, 94, 96) was undertaken using the (d,^{3}He) reaction at a deuteron energy of 34.4 MeV. The experimental angular distributions were compared with distorted-wave calculations in the finite-range approximation which include nonlocality in the distorted waves. The residual yttrium isotopes (A = 89, 91, 93, 95) have $\frac{1}{2}^-$ ground states, and the observed spectra can be interpreted in terms of a simple shell-model picture which considers hole and particle configurations in the $1g_{9/2}$, $2p_{1/2}$, $2p_{3/2}$, and $1f_{5/2}$ proton shells and allowed couplings in the $2d_{5/2}$ neutron shell. It was found that the filling of the $2d_{5/2}$ neutron shell apparently has a measurable effect on the relative amounts of the $(2p_{1/2})^2$ and $(1g_{9/2})^2$ proton admixtures in the zirconium ground states. The strength of the $(2p_{1/2})^2$ term in the ground-state wave functions was determined to be: 64% for ^{90}Zr, 55% for ^{92}Zr, 66% for ^{94}Zr, and 86% for ^{96}Zr. (auth)

18232 ON THE EXISTENCE OF DIRECTIONAL CORRELATIONS BETWEEN K X RAYS FOLLOWING ELECTRON CAPTURE AND NUCLEAR GAMMA RAYS. Fechner, J.; Guenther, C.; Huebel, H.; Raghavan, R. S.; Speidel, K.-H.; Toschinski, H.; Wolbeck, B. (Univ., Bonn). Phys. Lett., 26B: 374-5(Feb. 19, 1968).

Perepelkin recently reported anisotropies of K x ray $-\gamma$ directional correlations in several cases. These results are in contradiction to the theory. These experiments were repeated, and no anisotropy was found. (auth)

18233 RECOILLESS NUCLEAR RESONANCE ABSORPTION IN ^{145}Nd. Kaindl, G.; Moessbauer, R. L. (Technische Hochschule, Munich). Phys. Lett., 26B: 386-7(Feb. 19, 1968).

Recoilless nuclear resonance absorption was observed for the 67- and 72-keV γ rays of ^{145}Nd. This uniquely confirms the energy level scheme proposed for ^{145}Nd by Brosi et al. (auth)

18234 ISOBARIC SPIN FORBIDDEN EFFECTS IN (p,d) AND (d,p) REACTIONS ON Pb ISOTOPES. Bernstein, E. M.; Armstrong, D. D. (Los Alamos Scientific Lab., N. Mex.). Phys. Lett., 26B: 365-6(Feb. 19, 1968).

Excitation functions were measured for several (p,d) and (d,p) reactions on Pb isotopes. Anomalies in these reactions which are forbidden by isobaric spin selection rules were observed. The magnitude of the effects is different for different final states. (auth)

18235 NUCLEAR QUADRUPOLE MOMENTS OF THE NEUTRON-DEFICIENT ISOTOPES ^{131}Cs AND ^{132}Cs. Ackermann, F.; Otten, E. W.; zu Putlitz, G.; Schenck, A.; Ullrich, S. (Univ., Heidelberg). Phys. Lett., 26B: 367-8(Feb. 19, 1968).

The nuclear quadrupole moments of ^{131}Cs and ^{132}Cs were measured by hyperfine structure spectroscopy of the $6^2P_{3/2}$ and $7^2P_{3/2}$ states with the methods of level crossing and optical double resonance. The following results (including the Sternheimer correction) were obtained: $Q(^{131}\text{Cs}) = -0.57 \pm 0.01$ b, $Q(^{132}\text{Cs}) = +0.46 \pm 0.01$ b. The sign and size of $Q(^{131}\text{Cs})$ can be interpreted as further evidence of oblate nuclear deformation in the region $Z > 50$, $N < 82$. (auth)

18236 SYSTEMATICS OF ABSOLUTE TRANSITION PROBABILITIES OF K-FORBIDDEN GAMMA-RAY TRANSITIONS. Loebner, K. E. G. (Technical Univ., Munich). Phys. Lett., 26B: 369-70(Feb. 19, 1968).

All available experimentally determined absolute γ-ray transition probabilities between different intrinsic states in odd- and even-mass nuclei of the rare-earth region (with neutron numbers $89 \le N \le 114$ and proton numbers $62 \le Z \le 78$) and of the actinide region ($N \ge 134$) are compared to the Weisskopf estimate for different $|\Delta K|$ values. (auth)

18237 HALF-LIVES OF THE EXCITED STATES OF ^{46}Ti, ^{84}Rb, ^{99}Tc, ^{162}Dy, ^{164}Er, AND ^{196}Au. Sethi, B.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 166: 1227-33(Feb. 20, 1968).

The half-lives of some excited states of ^{84}Rb, ^{162}Dy, ^{164}Er, ^{46}Ti, ^{99}Tc, and ^{196}Au nuclei were measured by using the delayed-coincidence method. Upper or lower limits on half-lives are obtained in a few cases. (S.F.L.)

18238 ISOTOPE SHIFTS OF K X RAYS AND VARIATIONS OF NUCLEAR CHARGE RADII. Chester, R. B.; Boehm, F. (Cali-

fornia Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Rev., 166: 1206-12(Feb. 20, 1968).

The electronic Kα_1 isotope shifts were studied for the following sets of isotopes: $^{116-124}$Sn, $^{144-150}$Nd, $^{148-154}$Sm, $^{155-156-160}$Gd, $^{182-184-186}$W, $^{200-204}$Hg, and $^{206-208}$Pb. With the help of a curved-crystal spectrometer in the Cauchois geometry the relative wavelengths of fluorescently excited x rays for two enriched isotope samples were measured to a precision of 10^{-7}. The observed shifts, corrected for the normal and specific mass shifts, were compared with calculated shifts, taking into account the volume effect (adjusted for the dynamic quadrupole interaction), screening by the transition electron, and a term arising from the anomalous magnetic moment. The anomalies previously observed in the optical and muonic shifts are established with good accuracy by the present experiments. (auth)

18239 SPECTRA OF EVEN ISOTOPES OF CADMIUM AND TELLURIUM. **Pandharipande, V. R. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett., 26B: 344-5(Feb. 19, 1968).**

Some drawbacks in the conventional interpretation of the spectra of even isotopes of Cd and Te as collective quadrupole phonon states are indicated, and a different structure for these spectra is proposed. (auth)

18240 QUADRUPOLE MOMENT OF THE 2$^+$ PHONON AND THE STRUCTURE OF THE ODD MASS SPHERICAL NUCLEI. **Goswami, A.; Nalcioglu, O. (Case Western Reserve Univ., Cleveland). Phys. Lett., 26B: 353-6(Feb. 19, 1968).**

The effect of the coupling to the quadrupole moment of the phonon on the structure of the odd-mass nuclei is shown to be of great importance. In particular, it explains certain anomalous features in the low-energy spectra of odd-mass Ag isotopes. (auth)

18241 THE DECAY OF ^{188}Re. **Beraud, Robert; Berkes, Istvan; Daniere, Joannes; Escudie, Bernard; Levy, Michele; Marest, Gilbert; Rougny, Robert (Faculte des Sciences, Villeurbanne, France). Compt. Rend., Ser. A and B, 265: 1492-5 (Dec. 18, 1967). (In French).**

The spectrum obtained with a Ge(Li) detector made it possible to determine more precisely the energies and intensities of γ radiation in ^{188}Os. A decay scheme is proposed. (tr-auth)

18242 THE INTERNAL CONVERSION ELECTRON SPECTRUM EMITTED BY ATOMS IN FLIGHT: CASE OF THE α DECAY OF ^{241}Am. **Briancon, Chantal; Valadares, Manuel; Walen, Robert J. (CNRS, Orsay, France). Compt. Rend., Ser. A and B, 265: 1496-9(Dec. 18, 1967). (In French).**

The examination of the conversion electron rays (Doppler bands and satellite bands) emitted by atoms in flight as a result of α recoil in vacuum has shown that the conversion coefficients of the abnormal E1 radiation of 59 keV of ^{237}Np depends on the charge state of the emitter atom. (tr-auth)

18243 INVERSION IN THE DEFORMATION EFFECT FOR NEUTRON TRANSMISSION THROUGH ORIENTED ^{165}Ho. **McCarthy, J. S.; Fisher, T. R.; Shelley, E. G.; Safrata, R. S.; Healey, D. (Stanford Univ., Calif.). Contracts Nonr-225(67); Nonr-225(58); Nonr-225(86). Phys. Rev. Lett., 20: 502-4 (Mar. 4, 1968).**

Measurements of the "deformation effect" in the total cross section for neutrons on oriented ^{165}Ho over the energy range 0.330 to 5.60 MeV are reported. They are in good qualitative agreement with the prediction of a previous theoretical calculation, and the predicted inversion or sign change in the energy range 3 to 7 MeV is verified. (auth)

18244 EXCITED STATES IN ^{100}Ru STUDIED BY THE DECAY OF ^{100}Rh. **Kawakami, Hirokane; Hisatake, Kazuo (Tokyo Inst. of Tech.). J. Phys. Soc. Jap., 24: 614-23(Mar. 1968).**

The excited states of ^{100}Ru were reinvestigated by the decay of ^{100}Rh. Singles and coincidence ($\gamma-\gamma$, $e-\gamma$, and $\gamma-\gamma-\gamma$) gamma spectra were studied with a Ge(Li), two or three NaI(Tl) detectors, and a magnetic beta spectrometer. Observed gamma rays were those of 0.447(13), 0.540(100), 0.589(7), 0.67(weak), 0.75(~4), 0.822(30), 1.035(4), 1.109(21), 1.34(8), 1.362(24), 1.555(28), 1.927(13), 2.375(41), 2.526(4) and 0.511 annihilation radiation (11), where the numbers are energies in MeV and those in parentheses are intensities. The gamma ray of 2.526 MeV was newly found with both Ge(Li) and NaI(Tl) detectors. Gamma-gamma angular correlation was studied for almost all of the coincident gamma-ray pairs. The excited states of ^{100}Ru deduced by the above experiment are as follows: 0.540(2^+), 1.362(2^+), 1.88(3^+ or 2^+), 2.11 (?), 2.467(2^-), 2.915(2^-), and 3.066(?), where the numbers are excitation energies in MeV. (auth)

18245 SUM-COINCIDENCE STUDIES IN THE DECAY OF ^{182}Ta. **Murty, V. Radhakrishna; Jnanananda, Swami (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 5: 345-9 (Aug. 1967).**

The energy levels of ^{182}W were investigated with a stabilized fast-slow sum-coincidence spectrometer. Sum-coincidence spectra are recorded at gate energies of 1554, 1488, 1437, 1375, 1331, 1253, and 1222 keV, as well as at low gate settings at 580, 329, and 264 keV. The various cascades observed are in complete agreement with the decay scheme proposed by Bashandy et al. (Nucl. Phys., 52: 61(1964)). A new level at 680 keV, considered to be the fourth member of the ground-state rotational band with a spin and parity sequence ($I = 6^+$), is confirmed; and the new 147-keV gamma transition is observed in the sum-coincidence spectra. The weak and doubtful transition at 1437 keV is well established. (auth)

18246 STUDY OF BETA–GAMMA CORRELATIONS IN ^{198}Au. **Rao, W. V. S.; Appalacharyulu, K.; Sastry, D. L.; Jnanananda, Swami (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 5: 350-3(Aug. 1967).**

The energy dependence of the beta-gamma directional correlation was measured for the 960-412 keV beta-gamma cascade in the decay of gold-198, using a slow-fast scintillation assembly in the beta energy region 222.5 to 747.5 keV. Results from the integral correlation experiment showed that ϵ_4 was zero within the experimental errors, while differential correlation experiments showed that ϵ_2 was small but significant throughout the measured energy range and was in accordance with the ξ approximation. The maximum possible contribution of $\int B_{ij}$ matrix element to the 960-keV beta transition was estimated. The results compare closely with the previous data. (auth)

18247 EFFECT OF RESONANCE SCATTERING OF SODIUM ON RESONANCE ABSORPTION OF ^{238}U. **Tone, Tatsuzo; Ishiguro, Yukio; Takano, Hideki (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 601-6(Dec. 1967).**

The interference effects of the resonance scattering of Na on the resonance absorption of ^{238}U were investigated. The results for self-shielding factor obtained from exact treatment were compared with those from the usual conventional method, as well as with results based on the assumption that $\phi(u)\sigma_t$ = const. ($\phi(u)$: flux, σ_t : total cross section). In the exact treatment, the neutron spectrum used is obtained with accurate treatment of the slowing down by the elastic scattering of light and medium elements. In the $\phi(u)\sigma_t$ = const. assumption, the energy dependence of the Na resonance scattering cross section is taken into account as in the exact treatment, whereas only the averaged value is used in the conventional method. Self-shielding factors and their temperature dependence were calculated for several compositions and energy regions. It was found that the conventional method is not satisfactory, while the assumption that $\phi(u)\sigma_t$ = const. compares well with the exact treatment. (auth)

18248 PROMPT $\bar{\nu}$ MEASUREMENTS FOR THE SPONTANEOUS FISSION OF ^{240}Pu AND ^{242}Pu. **Boldeman, J. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). J. Nucl. Energy, 22: 63-72(Feb. 1968).**

The average number of prompt neutrons $\bar{\nu}$ emitted per fission was measured for the spontaneous fission of ^{240}Pu and ^{242}Pu relative to $\bar{\nu}$ for the spontaneous fission of ^{252}Cf. The measurements were performed with a large liquid scintillator and the values obtained were $\bar{\nu}(^{240}\mathrm{Pu}) = 2.168 \pm 0.009$ and $\bar{\nu}(^{242}\mathrm{Pu}) = 2.157 \pm 0.009$ relative to $\bar{\nu}(^{252}\mathrm{Cf}) = 3.784$ (assumed). (auth) (UK)

18249 MEASUREMENT OF THE NUMBER OF NEUTRONS PER FISSION FOR ^{252}Cf. **White, P. H. (Atomic Weapon Research Establishment, Aldermaston, Eng.); Axton, E. J. J. Nucl. Energy, 22: 73-7(Feb. 1968).**

The average number of prompt neutrons per fission for ^{252}Cf was found to be 3.787 from independent measurements of the absolute fission rate and the absolute neutron output. The random error is ±0.3%. Systematic errors are not expected to exceed ±0.8%. (auth) (UK)

18250 RECOMMENDED VALUES FOR THE NUMBER OF NEUTRONS PER FISSION. **Fillmore, F. L. (Atomic International, Canoga Park, Calif.). J. Nucl. Energy, 22: 79-97(Feb. 1968).**

The available experimental data for the value of ν for fissile and fertile isotopes are reviewed. The absolute determination of ν for ^{252}Cf is discussed, since this provides the standard for normalizing the other values. Based on weighted averages of the experimental data, recommended 2200 m/sec values are presented for ^{235}U, ^{233}U, ^{239}Pu and ^{241}Pu. The available data relating the dependence of ν on incident neutron energy are tabulated, and straightline fits to the data are made by the method of least squares. These results are of direct value in reactor calculations and the related evaluation of nuclear cross sections. Although there are instances where the data indicate structure of a more complicated nature, no attempt is made to analyze these situations. For practical purposes, a reasonably satisfactory fit to the data can be made with not more than two straight lines. (auth) (UK)

18251 CONTRIBUTION TO THE HISTORY OF FRANCIUM. Cranston, J. A. Chem. Brit., 4: 66(Feb. 1968).

The discovery of Fr from the initial indications that element 87 was formed in dual disintegration of mesothorium 2 to the confirmation of the production of ^{223}Fr in the dual disintegration of Ac, is reviewed. Consideration of the significance of dual disintegration in studies of nuclear binding forces is urged. (D.C.W.)

18252 COMPUTED VALUES OF THE SPECIFIC γ-RAY CONSTANT I FOR ^{137}Cs AND ^{60}Co. Attile, F. H. (Naval Research Lab., Washington, D. C.). Phys. Med. Biol., 13: 119-21(Jan. 1968).

It was considered that recalculation of the theoretical values of Γ would be useful because the value of W_{air} has been changed from 34.0 to 33.7 eV/ion pair, $(\mu_{en}/P)_{air}$ has been recalculated to give values slightly different from those in the NBS Handbooks, and the best value for the number of γ rays/disintegration for ^{137}Cs now appears to be 0.858. The formulas used for the recalculation are given. The value of Γ obtained for ^{137}Cs is 0.326 R hr^{-1} Ci^{-1} at 1 meter. For ^{60}Co, Γ for the 1.172-MeV line is 0.617; and for the 1.332-MeV line it is 0.68, giving a total of 1.298. (UK)

18253 ON-LINE ALPHA SPECTROSCOPY OF NEUTRON-DEFICIENT ACTINIUM ISOTOPES. Valli, Kalevi; Treytl, William J.; Hyde, Earl K. (Univ. of California, Berkeley). Phys. Rev., 167: 1094-1104(Mar. 20, 1968).

Isotopes of actinium lighter than mass 216 were studied in the Berkeley heavy-ion linear accelerator by bombardment of ^{209}Bi with ^{12}C, enriched ^{205}Tl and ^{203}Tl with ^{16}O, and ^{197}Au with ^{20}Ne. Silicon (Au) surface-barrier detectors were used in on-line measurements to determine α-decay characteristics. Mass-number assignments of ^{209}Ac through ^{215}Ac were made on the basis of excitation functions, genetic relations with radium isotopes, and systematic trends in α-decay energies. Half-lives and α-particle energies were determined. (auth)

18254 INTERNAL-CONVERSION STUDIES WITH ^{119m}Sn AND ^{117m}Sn. Bocquet, J.-P.; Chu, Y. Y.; Emery, G. T.; Perlman, M. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 167: 1117-21(Mar. 20, 1968).

Measurements were made with a magnetic spectrometer of the internal conversion-electron lines from the M4 and M1(E2) transitions which occur in cascade in the decay of ^{117m}Sn and ^{119m}Sn. In the case of ^{117m}Sn, the transition energies are 156.0 ± 0.1 keV (M4) and 158.6 ± 0.1 keV [M1(E2)]; $\alpha_K(158.6)$ was found to be 0.1373 ± 0.0030. ^{117m}Sn is shown to be a convenient reference standard for conversion-coefficient measurements, and working values of the "coefficient" for several kinds of measurement are given. In the case of ^{119m}Sn, the energies are 65.66 ± 0.01 keV (M4) and 23.875 ± 0.010 keV [M1(E2)]. Comparisons are made of measured subshell intensities with theoretical values, including those of Hager and Seltzer for the M subshells; and upper limits are set for the amounts of E2 admixture in the two M1 transitions. For the 23.875-keV M1 transition, the $L_1 : M_1 : N_1$ conversion ratios observed agree with the ratios of the electron densities near the nucleus of the bound 2s, 3s, and 4s electrons, in accord with the results of Drell and of Church and Monahan. (auth)

18255 SPIN DEPENDENCE OF THE ^{235}U LOW-ENERGY NEUTRON CROSS SECTION. Schermer, R. I.; Passell, L.; Brunhart, G.; Reynolds, C. A.; Sailor, L. V.; Shore, F. J. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 167: 1121-30 (Mar. 20, 1968).

The interaction of polarized monochromatic neutrons with polarized ^{235}U nuclei was used to study the spin dependence of the total cross section of ^{235}U at a number of neutron energies between 0.075 and 2.04 eV. Measurements were made primarily with a $^{235}U_{0.2}La_{0.8}Cl_3$ target in which appreciable nuclear polarization was produced. The results show that the 0.275-eV resonance is in the opposite spin state to the 1.14-eV resonance and to the major part of the thermal cross section. The 2.08-eV resonance is probably in the same spin state as the 0.275-eV resonance. If one assumes that ^{235}U has a negative magnetic moment, then $J = I - \frac{1}{2} = 3$ at 0.275 eV. None of the existing cross-section analyses are completely consistent with the observations for $E \leq 1.14$ eV. In ^{235}U metal a small "brute-force" nuclear polarization was detected, but there was no evidence of any hyperfine interaction. A somewhat larger nuclear polarization was observed in $^{235}UFe_2$, due to a negative hyperfine field of undetermined magnitude. (auth)

18256 ISOBARIC ANALOG STATES IN HEAVY NUCLEI. V. RESONANCES IN ^{90}Zr FROM PROTON INELASTIC SCATTERING. Long, D. D.; Fox, J. D. (Florida State Univ., Tallahassee). Phys. Rev., 167: 1131-(Mar. 20, 1968).

Isobaric-spin analog resonances were observed as compound-nucleus resonances in ^{90}Zr through the reaction $^{89}Y(p,p')^{89*}Y$. These resonances are compared with the predictions of a proposed weak-coupling model which explains the analog resonances in terms of the coupling of a single proton to excited states of the target nucleus. A tentative analysis of the results is performed in terms of a general expression for the cross section which contains an undefined scattering matrix. This equation is put in a form which shows the interference between the resonant and nonresonant cross sections. The weak-coupling model is not explicitly verified, but support is given for its validity. Also included are the measurements of the excitation energies of the first four excited states of ^{89}Y. (auth)

18257 FISSION FRAGMENT CHARGE DISTRIBUTIONS IN MASS CHAINS A = 132, 133, AND 134 AS A FUNCTION OF FRAGMENT KINETIC ENERGY. Gunther, H.; Siegert, G.; Gebert, R.; Kerr, D.; Konecny, E. (Univ., Geissen, Ger. Technische Hochschule, Munich). Z. Naturforsch., 22A: 1808-9(Nov. 1967).

Nuclear charge distributions for the fission-fragment mass chains A = 132, 133, and 134 were measured as a function of fragment kinetic energy. The fractional yields of nuclei with the magic neutron number N = 82 are shown to increase with fragment kinetic energy. (auth)

18258 NEUTRON LEVEL RESONANCE PARAMETERS OF FISSIONABLE NUCLEUS. Kirpichnikov, I. V. At. Energ. (USSR), 23: 6-19(July 1967). (In Russian).

Statistical distribution of the resonance level parameters and determination of mean magnitudes of the parameters in measuring cross sections of slow neutron interactions with fissioning nuclei are discussed. Systematic studies were made of the available experimental data on the fission process in order to verify the results obtained and compare them with the theoretical predictions. (tr-auth)

18259 INTERGRATED AND DIFFERENTIAL CROSS-SECTIONS OF FISSION ^{232}Th BY NEUTRONS NEAR THRESHOLD. Ermagambetov, S. B.; Smirenkina, L. D.; Smirenkin, G. N. At. Energ. (USSR), 23: 20-4(July 1967). (In Russian).

Relative measurements of cross section of ^{232}Th fission by neutrons in a sub threshold region at 0.6 MeV and over were obtained. In order to normalize the data in the neutron cross section handbook the measurements were expanded to neutrons with 3 MeV energy. The T(p,n) reaction in an electrostatic Van de Graaff generator was used as neutron source. The divergence of the magnitude for thermal neutron cross section of 0.06 ± 0.02 m barn from the magnitude extrapolated for σ_f magnitude at high energies is discussed. Combined analysis of fission cross section and angular distribution established the characteristics and consequent order of lower channel bands for ^{232}Th fission: $K^{\pi} = \frac{1}{2}^{+}, \frac{3}{2}^{-}$, and $\frac{3}{2}^{+}$. (tr-auth)

18260 DECAY OF ^{119m}Te AND THE LEVEL STRUCTURE OF ^{119}Sb. Singru, R. M.; Devare, S. H.; Devare, H. G. (Tata Inst. of Fundamental Research, Bombay). Indian J. Pure Appl. Phys., 5: 377-81(Sept. 1967).

The decay of ^{119m}Te was investigated using a Ge solid-state detector and a $\pi\sqrt{2}$ double-focusing spectrometer for the study of the gamma and conversion-electron spectra. The energies and the relative intensities of the gamma transitions were determined with greater accuracy than before. The K/L conversion ratios were determined for the 153.0-, 163.8-, and 269.7-keV transitions, and the K conversion coefficients for the 153.0-, 269.7-, and 1212-keV gamma transitions. Gamma-gamma directional correlation measurements were made for the 944-270, 1097-270, 2095-270, and 153-1212 keV cascades. On the basis of these studies, the following levels in ^{119}Sb and their corresponding spin and parity assignments are proposed: 270 keV ($\frac{7}{2}^{+}$), 1048 keV ($\frac{7}{2}^{+}, \frac{9}{2}^{+}$), 1212 keV, ($\frac{7}{2}^{+}$), 1365 keV ($\frac{9}{2}^{-}$), 2281 keV ($\frac{9}{2}^{-}, \frac{11}{2}^{-}$), 2292, 2349 keV ($\frac{9}{2}^{-}, \frac{11}{2}^{-}$) and 2365 keV ($\frac{9}{2}^{-}$). The half-lives of the 270-, 1212-, and 1365-keV levels were studied by the time-to-amplitude conversion technique and are shown to be ≤0.4 nsec. (auth)

18261 ALPHA-ACTIVE GOLD ISOTOPES. Siivola, Antti (Univ. of Helsinki. Univ. of California, Livermore). Nucl. Phys., A109: 231-5(1968).

Neutron-deficient isotopes of gold were produced through heavy-ion-induced nuclear reactions from various rare-earth targets. Their excitation functions, alpha-particle energies, and half-lives were measured. The decay characteristics are given. (S.F.L.)

18262 AN INVESTIGATION OF THE DECAY ^{95}Zr → ^{95}Nb → ^{95}Mo. Broman, L.; Boreving, S. (Chalmers Univ. of Tech., Gothenburg, Sweden). Ark. Fys., 34: 259-62(1967).

The decay ^{95}Zr → ^{95}Nb → ^{95}Mo was investigated by means of a Ge(Li) detector. Special attention was paid to accurately determining the ratio between the intensities of the 723- and 756-keV gamma lines in the first decay. This ratio was measured to be 0.776 ± 0.013. Branchings to other levels in ^{95}Nb were searched for but were not found. (auth) (Sweden)

18263 DECAY OF THE 16.3-MIN ^{182}Ta ISOMER. Hoejeberg, M.; Malmskog, S. G. (Aktiebolaget Atomenergi, Studsvik, Sweden). Ark. Fys., 35: 51-6(1968).

Some transitions in the decay of the 16.3-min ^{182}Ta isomer were studied with a Ge(Li) detector and a double lens electron-electron coincidence spectrometer. Gamma-ray and conversion electron intensities were measured. From a delayed coincidence experiment, it was concluded that both of the two lowest excited states in ^{182}Ta had a half-life less than 30 psec. (auth) (Sweden)

18264 A STUDY OF ENERGY LEVELS IN EVEN-EVEN YTTERBIUM ISOTOPES BY MEANS OF (d,p), (d,t), AND (d,d') REACTIONS. Burke, D. G.; Elbek, B. Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 36: 43p(1967).

Targets prepared from separated isotopes of all the stable ytterbium nuclei were bombarded with 12-MeV deuterons from a tandem Van de Graaff accelerator. The reaction products were analyzed with a broad-range, single-gap, magnetic spectrograph with an overall resolution of 0.1%. In order to study the levels in even nuclei, the triton and proton spectra from ^{171}Yb and ^{173}Yb targets and the inelastic deuteron spectra from ^{168}Yb, ^{170}Yb, ^{172}Yb, ^{174}Yb, and ^{176}Yb targets were recorded. The systematics of the (d,d') population of vibrational bands are discussed and utilized for the identification of γ- and octupole vibrational levels in nuclei in which these had not previously been observed. The (d,p) and (d,t) cross sections are compared with the predictions of stripping theory of deformed nuclei calculated with empirical values of the single-particle cross sections obtained from experiments on even-even targets. The populations of ground states are in agreement with these predictions as modified by pairing theory. The (d,p) and (d,t) populations of several rotational bands show patterns which resemble those expected for two-quasiparticle states, although in many cases the absolute cross sections were smaller than predicted for a pure configuration. The stripping and pickup data for the vibrational bands offer strong experimental evidence that these states can be considered as superpositions of two-quasiparticle states. The predicted components are found to be present, but the theoretical amplitude often shows only qualitative agreement with the observed cross sections. (auth)

18265 A STUDY OF ENERGY LEVELS IN ODD-MASS GADOLINIUM NUCLEI BY MEANS OF (d,p) AND (d,t) REACTIONS. Tjoem, P. O.; Elbek, B. Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 36: 54p(1967).

The energy levels of ^{151}Gd, ^{153}Gd, ^{155}Gd, ^{157}Gd, ^{159}Gd, and ^{161}Gd were investigated by means of (d,p) and (d,t) reactions on the stable even gadolinium isotopes. The deuteron energy was 12.1 MeV; and the charged reaction products were analyzed in a magnetic spectrograph at 60, 90, and 125°. Application of theoretical and semi-empirical rules for the cross sections allowed the identification of states belonging to 16 different Nilsson orbitals, most of them in several nuclei. In the lighter gadolinium nuclei, the onset of deformation gives rise to complicated level structures which only in part can be explained by the Nilsson model. The spectra of these nuclei also show several effects which can be ascribed to the crossing of levels with the same spin and parity, but belonging to different oscillator shells. The experimental level scheme based on the observation of the $7/2^+$ [404] and $1/2^+$ [651] Nilsson orbitals in ^{155}Gd is compressed by approximately a factor of two compared to the theoretical level scheme. (auth)

18266 PROTON SHELL-MODEL POTENTIALS FOR LEAD AND THE STABILITY OF SUPERHEAVY NUCLEI. Rost, E. (Univ. of Colorado, Boulder). Phys. Lett., 26B: 184-7(Jan. 22, 1968).

Nuclear potentials for heavy nuclei were determined by performing a least-squares fit to recent stripping and pickup data in the lead region for the single-particle and hole energies. The well parameters were applied to the super-heavy region ($A \sim 300$) and yielded no significant magic gap. (auth)

18267 ON HIGHER-ORDER EFFECTS IN SOME ABNORMAL ALLOWED BETA TRANSITIONS. Sastry, K. S. R.; Ouellette, R. J.; Sharma, Y.; Strange, R. (Univ. of Massachusetts, Amherst). Phys. Lett., 26B: 207-9(Jan. 22, 1968).

Essentially isotropic β-γ directional correlations were obtained in several highly retarded allowed β transitions. The implications of the results are examined using Morita's theory for higher-order effects. (auth)

18268 ABSOLUTE FISSION-YIELDS OF ^{99}Mo AND ^{139}Ba IN THE THERMAL NEUTRON FISSION OF ^{235}U. von Gunten, H. R.; Hermann, H. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Radiochim. Acta, 8: 112-14(Nov. 1967).

A direct technique was used to measure the fission yields of ^{99}Mo and ^{139}Ba from thermal neutron fission of ^{235}U. Fission counting and isolation of fission products were done in the same thin sample of fissionable material. An Al parallel-plate type fission counter was used with uniformly electroplated deposits of 29 mm dia which contained 0.08 to 0.2 mg of ^{235}U(99.5%). The fission counter was positioned in the heavy-water reactor DIORIT in front of a beam hole. The thermal neutron flux at the counter at full reactor power was approximately 4×10^8 n cm^{-2} sec^{-1}, the epithermal flux was approximately 2×10^7 n cm^{-2} sec^{-1}, and the fast flux was 6×10^7 n cm^{-2} sec^{-1}. Sample and lining were dissolved after completion of fission counting and ^{99}Mo and ^{139}Ba were isolated by standard radiochemical procedures. (S.F.L.)

18269 ANGULAR ANISOTROPY OF GAMMA QUANTA AND KINETIC ENERGY OF FISSION FRAGMENTS. Ivanov, O. I.; Kushnir, Yu. A.; Smirenkin, G. N. JETP Lett. (USSR) (Engl. Transl.), 6: 327-9(Nov. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 898-901(Nov. 15, 1967).

The dependence of the angular anisotropy of prompt γ rays on the kinetic energy and mass ratio of fission fragments from the thermal neutron fission of ^{235}U was investigated. The energies of the fission fragments were measured in coincidence with the γ quanta using solid-state detectors and a plastic scintillator detector for the fragments and the γ quanta, respectively. (D.C.W.)

18270 EFFECTIVE RESONANCE INTEGRALS OF SEPARATED TUNGSTEN ISOTOPES FROM REACTIVITY MEASUREMENTS. Shook, Donald F.; Bogart, Donald (Lewis Research Center, Cleveland). Nucl. Sci. Eng., 31: 415-30(1968).

Measurements of effective resonance integrals for separated tungsten isotopes enriched in ^{182}W, ^{183}W, ^{184}W, and ^{186}W, and for natural tungsten and gold were made over a range of sample size. The effective integrals were determined by using a small homogeneous reactor to measure epicadmium reactivities for samples located at the center of the core. For calibration of the reactivity data, and to extend the measurement for gold over a wide range of sample size, relative γ-ray activities of cadmium-covered thin samples of gold were also measured. The experimental results were compared with effective resonance integrals calculated by the Nordheim integral method and using recently measured isotopic resonance parameters. Agreement between the calculations and experimental results for ^{182}W, ^{183}W, and ^{184}W were generally good. However, for the ^{186}W samples and for thick samples of natural tungsten, the calculations overestimated experimental effective integrals by 10 to 20% because of failure of the flat source approximation employed. For ^{186}W, the use of a radiation width of 0.044 ± 0.004 eV for the highly scattering 18.8-eV resonance brought calculations and experiment into better agreement. For natural tungsten, the experimental results indicated significant overlap effects for resonances of constituent isotopes in thick samples. (auth)

18271 DETERMINATION OF DILUTE ^{186}W AND ^{184}W RESONANCE INTEGRALS BY ACTIVATION. Pierce, Clarence R.; Shook, Donald F. (Lewis Research Center, Cleveland). Nucl. Sci. Eng., 31: 431-9(1968).

The effective resonance integrals of ^{186}W and ^{184}W as contained in natural tungsten were obtained for sample thicknesses from 0.25 to about 10^{-7} cm. Thin-sample activations yielded dilute resonance integrals of 441 ± 22 b for ^{186}W and 14.9 ± 1.6 b for ^{184}W. Since the 18.8-eV resonance of ^{186}W constituted 92% of the dilute resonance integral for this isotope, and since the neutron scattering width was measured accurately, the measured dilute integral provided a radiative capture width of 0.041 ± 0.003 eV for this resonance. The scattering widths for the important resonances of ^{184}W are also known accurately; an average capture width of 0.062 ± 0.007 eV for ^{184}W was obtained from the measured dilute integral. In the thick-sample region, values of effective resonance integrals for ^{186}W computed by the Nordheim integral method were found to overestimate experimental values for ^{186}W as contained in natural tungsten. This overestimate might be caused by overlap of resonances in ^{182}W and ^{186}W and by inadequacy of the flat source assumption in the calculation. A determination of 76.4 ± 0.7 days was made for the half-life of ^{185}W. (auth)

18272 MEASUREMENT OF THE RATIO OF THE NUCLEAR MAGNETIC MOMENTS OF ^{109}Cd AND ^{111}Cd 109 ISOTOPES OF

CADMIUM. Leduc, Michele; Brossel, Jean (CNRS, Paris). Compt. Rend., Ser. A and B, 266: 12-14(Jan. 3, 1968). (In French).

If the 109 and 111 isotopes of Cd are oriented nuclearly by optical pumping by the 3,261-Å ray, it is possible to measure with precision the ratio of their nuclear resonance frequencies in the same magnetic field. The value obtained was $\nu_{111}/\nu_{109} = 3.5929795 \pm 20 \times 10^{-7}$. (tr-auth)

18273 REINVESTIGATION OF THE DECAY OF 2.2-HOUR ^{138}Pr. Nakayama, Hisayoshi; Fujioka, Manabu; Hisatake, Kazuo (Tokyo Inst. of Tech.). J. Phys. Soc. Jap., 24: 623-5(Mar. 1968).

The excited states of ^{138}Ce following the decay of 2.2-hour ^{138}Pr were reinvestigated using Ge(Li) and NaI(Tl) detectors. Weak gamma rays of 0.389 and 0.546 MeV, which were reported previously, were confirmed in a Ge(Li) singles and NaI(Tl)–NaI(Tl) coincidence spectra. Two levels at 2.206 and 2.752 MeV in ^{138}Ce are proposed. (auth)

18274 STUDIES ON GAMMA DECAY OF ^{180m}Hf. El-Nesr, M. S.; El-Sayad, G. M. (Atomic Energy Establishment, Cairo). J. Phys. Soc. Jap., 24: 610-14(Mar. 1968).

The decay of 5.5-hr ^{180m}Hf was studied with double-focusing beta-ray spectrometers. Both internal and external conversion electrons were measured for most of gamma transitions in the decay. The corresponding conversion coefficients were obtained. Three new weak lines were observed with energies of 547.6 ± 0.5, 772.3 ± 0.7 and 832.0 ± 0.8 keV. A decay scheme consistent with the observations was constructed. Arguments for parity mixing in ^{180}Hf are given. Implications of the results for current nuclear theories are discussed. (auth)

18275 ANGULAR DISTRIBUTION OF PHOTOFISSION FRAGMENTS NEAR THRESHOLD. Rabotnov, N. S. (Inst. of Physics and Energetics, Obninsk, USSR); Smirenkin, G. N.; Soldatov, A. S.; Ysachev, L. N.; Kapitza, S. P.; Tsipeniuk, Yu. M. Phys. Lett., 26B: 218-19(Jan. 22, 1968).

The results of measurements of angular distributions of the photofission fragments for ^{232}Th, ^{238}U, ^{240}Pu, ^{242}Pu, and ^{239}Pu nuclei in the bremsstrahlung energy interval $E_{max} = 5$ to 8 MeV are reported and discussed. These results support the hypothesis about approximate conservation of the quantum number K at moderate excitation energies. (auth)

18276 THE REACTION ^{207}Pb(d,pγ_0)^{208}Pb AT 10 MeV. Ballini, R.; Cindro, N.; Delaunay, J.; Fouan, J. P.; Nathan, O.; Passerieux, J. P. (Centre d'Etudes Nucleaires, Saclay, France). Phys. Lett., 26B: 215-17(Jan. 22, 1968).

Proton-gamma coincidences in the ^{207}Pb(d,pγ)^{208}Pb reaction are observed. Two strongly excited states at 5.28 and 5.96 MeV, respectively, are found to decay directly to the ground state of ^{208}Pb. It is proposed that these states have $J^\pi = 1^-$. (auth)

18277 ON UNDERSTANDING THE TRANSITION BETWEEN SPHERICAL AND DEFORMED ODD-A GADOLINIUM NUCLEI. Sheline, R. K.; Shida, Y. (Florida State Univ., Tallahassee). Contract AT(40-1)-2434. Phys. Lett., 26B: 210-12(Jan. 22, 1968).

A combination of two different potential systems involving prolate deformations is proposed to explain the intensity and energy systematics of the Nilsson states populated in ^{155,157,159}Gd by (d,p) and (d,t) reactions. In the group of states associated with the more nearly spherical potential, the absence of regular rotational patterns is attributed to the mixing of principal harmonic oscillator shells and to severe Coriolis coupling. (auth)

18278 MAGNETIC MOMENT OF THE FIRST EXCITED STATE IN ^{133}Cs BY THE MOESSBAUER EFFECT. Campbell, L. E.; Perlow, G. J. (Argonne National Lab., Ill.). Nucl. Phys., A109: 59-61(1968).

The Mössbauer effect in an external magnetic field of 77.65 kG was used to determine the magnetic moment of the first excited state in ^{133}Cs at 81 keV. The result is $\mu_{ex} = +3.44 \pm 0.02$ n.m. (auth)

18279 PRECESSION MEASUREMENTS FOLLOWING COULOMB EXCITATION WITH OXYGEN IONS: V. Hf IONS RECOILING INTO LIQUID GALLIUM. Ben-Zvi, I.; Gilad, P.; Goldring, G.; Hillman, P.; Schwarzschild, A.; Vager, Z. (Weizmann Inst. of Sciences, Rehovoth, Israel). Nucl. Phys., A109: 201-4(1968).

Precession measurements were carried out for the 2^+ states in ^{176}Hf, ^{178}Hf, and ^{180}Hf. The nuclei were excited by oxygen ions of 34 MeV and embedded by recoil into liquid gallium which was found to provide an unperturbed environment. (auth)

18280 LEVEL STRUCTURE OF ^{117}In FROM THE DECAY OF ^{117}Cd. Pandharipande, V. R.; Prasad, K. G.; Sharma, R. P.; Thosar, B. V. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A109: 81-93(1968).

The levels in ^{117}In populated in the decay of ≈ 2.7-h ^{117}Cd and ^{117m}Cd were studied using a Ge(Li) detector and scintillation techniques. In all 45 gamma rays were identified. A total of 23 energy levels extending up to 2461 keV is proposed on the basis of the gamma–gamma and beta–gamma coincidence measurements. The K-conversion coefficient of the 88-keV transition is measured to be 1.3 ± 0.3. The gamma–gamma directional correlations of 1028-1068 keV and 567-1430 keV cascades were found to be $W(\theta) = 1 - 0.022(\pm 0.012)P_2(\cos\theta) + 0.015(\pm 0.038)P_4(\cos\theta)$, $W(\theta) = 1 - 0.011(\pm 0.012)P_2(\cos\theta) + 0.060(\pm 0.038)P_4(\cos\theta)$. The beta–gamma differential correlation of the beta group feeding the 748-keV level and the following 433-keV gamma ray is found to be isotropic. The levels at 660, 748, 881, 1249, and 1715 keV are identified as the members of a possible $K = 1/2^+$ rotational band. The levels at 860, 950, 1056, 1068, and 1430 keV are suggested to be the members of a ($9/2^+$ proton hole $+2^+$ core) multiplet. The possible nature of the other higher-excited states is discussed. (auth)

18281 NEUTRON CROSS SECTIONS OF Pr, Yb, Lu, Er, Ho, and Tm. Zimmerman, R. L.; Amaral, L. Q.; Fulfaro, R.; Mattos, M. C.; Abreu, M.; Stasiulevicius, R. (Instituto de Energia Atomica, Sao Paulo, Brazil). pp 53-9 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB–140(Vol.1); CONF-661014–(Vol.1).

The total neutron cross sections of praseodymium, ytterbium, lutetium, erbium, holmium, and thulium were measured by transmission within the neutron energy range 0.001 to 1.0 eV. Special attention was given to obtaining values at the thermal energy 0.025 eV. A crystal spectrometer coupled with a mechanical monochromator, and a slow chopper, were used. Powder samples of the oxides were supplied in high purity, with particular care to eliminate contamination by the rare earths of high neutron cross section. The data were analyzed to determine the nuclear absorption and the nuclear scattering cross sections. The effects of nuclear resonances and of the atomic paramagnetic scattering were properly considered. In the case of lutetium, the parameters of the first resonance are presented. (auth)

18282 TOTAL CROSS SECTIONS OF DYSPROSIUM, LUTETIUM, AND IRIDIUM FOR NEUTRONS OF ENERGY BETWEEN 0.01 AND 10 eV. Brunner, J.; Widder, F. (Federal Inst. for Reactor Research, Wuerenlingen, Switzerland). pp 61-70 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB–140(Vol.1); CONF-661014–(Vol.1).

The measurements described have been started in order to improve the basic data for the thermal neutron detector dysprosium and the "neutron thermometer" lutetium. For iridium more accurate cross sections have been requested for the two resonances around 1 eV which can be used for the measurement of resonance absorption in the 1.06-eV resonance in ^{240}Pu. The total neutron cross sections of dysprosium, lutetium, and iridium were measured in the energy range between 0.01 eV and 10 eV with the EIR mechanical chopper installation at the reactor DIORIT. The resolution obtained is 0.5 μs/m including the time analyzer channel width. For the dysprosium measurements, samples of metal and oxide were used, for lutetium the oxide, and for iridium the metal only. The purity of the samples was 99.9%, the main impurities being Ho and Y in the dysprosium samples and Yb and Tm in the lutetium samples, with negligible influence on the accuracy of the measurements. Corrections to the measurements were applied for deadtime, oxygen content, and time-dependent background. The results are given in the form of curves. For some well-resolved resonances, the resonance parameters which were calculated with the computer program Atta and Harvey are indicated. All data accessible in the literature for the energy range considered are collected. A careful discussion of the results is given and best values are proposed. (auth)

18283 NEUTRON STRENGTH FUNCTION MEASUREMENTS IN THE MEDIUM AND HEAVY NUCLEI. Uttley, C. A.; Newstead, C. M.; Diment, K. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 165-74 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB–140(Vol.1); CONF-661014–(Vol.1).

Neutron total cross-section measurements were made between 100 eV and 1 MeV on nuclei near the mass-100 and mass-240 p-wave resonances using the Harwell "booster" pulsed neutron source and the 120-m and 300-m spectrometers. The s-wave strength function s_0 and distant level parameter R_0^∞ have usually been separately determined at lower energies and the corresponding p-wave parameters are obtained from a least-squares fit to the higher energy (>10 keV) total cross section using the average collision function expression from R-matrix theory. The d-wave strength function is also determined using plausible assumptions on the average parameters of the higher partial waves. The nuclei studied are ^{93}Nb, ^{98}Mo, ^{100}Mo, ^{103}Rh, ^{232}Th, ^{233}U, ^{235}U, ^{238}U, and ^{239}Pu. (auth)

18284 STUDY OF THE DISTRIBUTION OF THE PARTIAL RADIATIVE WIDTHS OF ^{196}Pt USING A Ge(Li) DETECTOR. Samour, C.; Jackson, H. E.; Chevillon, P. L.; Julien, J.; Morgenstern, J. (CEN, Saclay, France). pp 175-82 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

In the past, the distributions of partial radiative widths could not be determined correctly because of the poor resolution of detectors. With germanium detectors, the distributions of partial radiative widths in the case of ^{196}Pt + n can be studied accurately. The results obtained for a large number of resonances in the energy range from 0 to 600 eV are presented and are discussed. (auth)

18285 VALUE OF THE STRENGTH FUNCTION S_0 AND THE SCATTERING RADIUS R' AS A FUNCTION OF MASS NUMBER AND FLUCTUATION OF S_0 AS A FUNCTION OF ENERGY IN THE ENERGY RANGE BETWEEN 0 AND 300 keV. Morgenstern, J.; De Barros, S.; Chevillon, P. L.; Gauthier, M. J.; Jackson, H.; Julien, J.; Samour, C. (CEN, Saclay, France). pp 183-92 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

The strength function S_0 was studied as a function of mass number A in the range between 50 and 200, especially in the vicinity of the 3S and 4S giant resonances. The maximum of S_0 for A ~ 145 appears to be less wide than had been estimated by the various models. Fluctuations in S_0 as a function of neutron energy (in the case of Co, Pr, and others) are indicated and are discussed. (auth)

18286 INELASTIC SCATTERING OF FAST NEUTRONS BY ^{235}U. Armitage, B. H.; Ferguson, A. T. G.; Montague, J. H.; Starfelt, N. (Atomic Energy Research Establishment, Harwell, Eng.). pp 383-92 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

Measurements of the spectra of neutrons scattered by ^{235}U were made by time-of-flight techniques using the Harwell 3-MeV pulsed accelerator at incident neutron energies of 0.12, 0.2, 0.4, 0.55, 0.75, 1.0, 1 5, and 1.8 MeV. All the data were obtained at an observation angle of 90° with a flight path of 1.5 m. The cross sections for inelastic neutron scattering were calculated after subtraction of contributions from fission and radioactivity. Even with a resolution of about 10 keV, only the low-lying levels were sufficiently well resolved to give structure in the scattered neutron spectrum. (auth)

18287 PULSED FAST NEUTRON RESEARCH AT THE LOS ALAMOS VAN DE GRAAFF ACCELERATOR. pp 419-28 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

The activities, facilities, and plans of the Los Alamos time-of-flight group are discussed. The various projects are briefly described; results from some of the experiments are given. (D.C.W.)

18288 MEASUREMENT OF ABSORPTION CROSS SECTIONS FOR NEUTRONS WITH A MEAN ENERGY OF 24 keV BY TRANSMISSION IN A SPHERICAL GEOMETRY. Belanova, T. S.; Van'kov, A. A.; Mikhailus, F. F.; Stavisskii, Yu. Ya. (Inst. of Physics and Energetics, Obninsk, USSR). pp 455-8 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

The measurement of fast-neutron absorption cross sections σ_a by the method of transmission in a spherical geometry is described. The results are reported of experiments for neutrons from a Sb–Be source with a mean energy of 24 keV for the following elements: Cr, Ni, Cu, Zn, Sr, Zr, Nb, Mo, Ag, Cd, In, Sn, Sb, W, Au, Hg, Pb, Bi, Th, ^{238}U, ^{235}U, ^{239}Pu. In the case of fissionable isotopes the sum of the fission and radiative capture cross sections $\sigma_f + \sigma_r$ was measured. As neutron detectors, a counter of independent length and a system comprising a water tank and fission chambers for recording thermal neutrons were used. To investigate the effect of the resonance blocking of fast neutrons, samples of absorbent material diluted with a lead–bismuth alloy as scatterer were used; the thickness of the samples was also varied. The experimental data were processed on the basis of a calculation of transmissions which was carried out by the Monte Carlo method on a computer. Partial results of the calculation are presented in tables of various coefficients, in a form suitable for interpolation. The possibilities and limitations of the spherical transmission method are discussed from the point of view of obtaining absolute values for absorption cross sections. (auth)

18289 FISSION PRODUCT ABSORPTION IN THERMAL REACTORS. Walker, W. H. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 521-36 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

The current status of the knowledge of fission-product yields and cross sections is outlined, and the data now in use at Chalk River is given. This data has been incorporated into a computer program (FISSPROD) which takes account of accumulation of radioactive nuclides with half-lives >5 hr and changes in flux, the epithermal component, and reactor temperature. Computer results are used to demonstrate the effect on reactivity of uncertainties in the basic nuclear data. The fission-product absorption in ^{233}U, ^{235}U, and ^{239}Pu has recently been determined from reactor oscillator measurements of samples irradiated to 2 to 3 n/kb (AECL-2510). The results are compared to FISSPROD calculations, and the significance of the differences is discussed. (auth)

18290 PROMPT FISSION NEUTRONS MEASUREMENT OF $\bar{\nu}$ AND OF THE PROBABILITIES P(ν) OF EMISSION OF ν NEUTRONS. Baron, E.; Frehaut, J.; Ouvry, F.; Soleilhac, M. (CEN de Bruyeres le Chatel, France). pp 57-66 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

Using a large liquid scintillator in conjunction with a fission-fragment detector, it is hoped to measure the values of $\bar{\nu}$ and P(ν) for different fissile materials to better than 1% in fissions produced by neutrons in the energy range 4 to 14 MeV. To estimate the various sources of error in these measurements, preliminary work was carried out on the spontaneous fission of ^{252}Cf and ^{240}Pu: measurement of the efficiency of the liquid scintillator; variation of $\bar{\nu}$ with the kinetic energy of the fragment detected; variation of the efficiency of the liquid scintillator with the geometry of the fission-fragment detector; correction of the experimental results and experimental check of these corrections. The P(ν) of ^{252}Cf and the $\bar{\nu}$ and P(ν) of ^{240}Pu in spontaneous fission were measured. In absolute values, it is the inexact knowledge of the reference $\bar{\nu}$ (^{252}Cf) which limits the accuracy of these measurements. (auth)

18291 MEASUREMENTS OF ETA, ALPHA, AND NEUTRON CROSS SECTIONS FOR ^{239}Pu ON THE HARWELL NEUTRON TIME-OF-FLIGHT SPECTROMETER. Patrick, B. H.; Schomberg, M. G.; Sowerby, M. G.; Jolly, J. E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 117-27 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

Eta values and total and fission cross sections were measured using the Harwell 45-MeV electron linear accelerator neutron time-of-flight spectrometer. The 34.9-m flight path, with a resolution of 7.2 ns/m, was used for the energy range 10 eV to 1 keV; and the 97.5-m flight path, with a resolution of 2.5 ns/m, was used for the energy range from 50 eV to 30 keV. The experimental methods employed were similar to those of Brooks et al., in which the fission neutron yield and the transmission of a number of samples of different thicknesses are measured together with the shape of the incident neutron spectrum, all the measurements being made with the same resolution. In the yield measurements, fast neutrons from fission events were detected in liquid scintillators, and pulse-shape discrimination was used to reject events caused by gamma rays. The transmission measurements were performed with a lithium glass scintillator, and a 1/V detector was used to measure the spectrum. Backgrounds were measured using the "black resonances" technique. The measurements at 34.9 m were normalized in the region of 10 eV to the eta values obtained by Brooks et al. and the eta values from the 97.5-m measurements were normalized to the 34.9-m measurements in the region of 50 eV. The results were corrected for multiple scattering in the samples.

Capture cross sections were derived from the total and fission cross sections by assuming values for the scattering cross section. A direct measurement of alpha (the ratio of the capture-to-fission cross sections) is in progress over the energy range 10 eV to 30 keV. This will lead to a better estimate of the capture cross sections since alpha measurements are not so sensitive to the magnitude of the scattering cross section. (auth)

18292 FISSION CROSS SECTIONS OF ^{238}Pu and ^{241}Am FOR MONOCHROMATIC RESONANCE NEUTRONS. Gerasimov, V. F. (Inst. of Atomic Energy, Moscow). pp 129-33 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

A study was made of the dependence of the fission cross sections of ^{238}Pu on neutron energies in the range 0.02 to 100 eV and of ^{241}Am in the range 0.02 to 50 eV. The results of measurements of $\sigma_0\Gamma$ for the first five resonances of ^{238}Pu are given. Fission widths were estimated for three resonances of ^{238}Pu and thirteen resonances of ^{241}Am. Measurements of the dependence of the fission cross sections of isotopes of transuranium elements in the resonance range of neutron energies is becoming of increasing importance, both in regard to the design and installation of nuclear reactors with high neutron flux and in connection with fission physics. Measurements of the fission cross sections of ^{238}Pu and ^{241}Am using the time-of-flight method on a linear electron accelerator are reported. (auth)

18293 MEASUREMENT OF THE NEUTRON TOTAL CROSS SECTION OF ^{240}Pu. Boeckhoff, K. H.; de Keyser, A.; Horstmann, H.; Kolar, W.; Martin, H. (Central Bureau for Nuclear Measurements, Geel, Belg.). pp 135-45 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

The neutron total cross section of ^{240}Pu was determined by time-of-flight techniques in the energy range from 20 to about 800 eV. For 36 of 42 resonances in this region values for Γ_n^0 were determined by shape analysis. Between 800 eV and 5 keV, the resonance structure was investigated. In this energy range 116 resonances could be detected. The experiment was performed using a 60-MeV electron linear accelerator as a pulsed neutron source. Nominal resolutions are given. (auth)

18294 DETERMINATION OF THE SPIN OF RESONANCES IN FISSILE NUCLEI. Michaudon, A. (CEN, Saclay, France). pp 161-84 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

Direct and indirect methods of determining the spins of resonances in fissionable nuclei are explained. Techniques involving the transmission of polarized neutrons through polarized targets are considered first, together with resonance analysis for conventional measurements. Techniques requiring the properties of capture or fission processes that depend on the spin state are then discussed. Experimental results that have been obtained for ^{239}Pu and ^{235}U by the various techniques are presented and discussed. (D.C.W.)

18295 SPIN ASSIGNMENTS OF LOW-ENERGY RESONANCES IN ^{239}Pu. Asghar, M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 185-94 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

Neutron scattering measurements were made up to about 300 eV on ^{239}Pu with the existing neutron scattering detector, which was modified to take account of the fission neutrons. Combining these data with the published transmission data ($g\Gamma_n$,Γ), spin assignments of 45 resonances were made. If the resonances assigned by other workers are included, the average values of fission widths for 0^+ and 1^+ resonances up to 200 eV are found to be 218.2 and 42.1 MeV, respectively. It is shown that this average value of fission width (42.1 MeV) for 1^+ resonances is inconsistent with the hypothesis of 1^+ resonances fissioning through a 1^+ two quasiparticle transition state, and one needs a 1^+ transition state at a much lower energy to account for this result. This state may be a 1^+ combination transition state formed from mass asymmetry and bonding vibrations. (auth)

18296 TOTAL AND FISSION CROSS SECTIONS OF ^{239}Pu: STATISTICAL STUDY OF THE RESONANCE PARAMETERS. Derrien, H.; Blons, J.; Eggermann, C.; Michaudon, A.; Paya, D.; Ribon, P. (CEN, Saclay, France). pp 195-210 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

The total and fission cross sections of ^{239}Pu were measured using linear accelerator at Saclay as a pulsed source of neutrons. The total cross section was measured in the range from 4 to 700 eV, and the best resolution used was 1.5 ns/m. The fission cross section was measured between 4 eV and 6 keV with a best resolution of 6 ns/m. The transmission measurements on five samples were made at the temperature of liquid nitrogen, and comparisons made with supplementary experiments at ambient temperature made it possible to determine the Doppler broadening factor ($\Delta = \eta\sqrt{E}$). The resonances were identified from 4 to 500 eV in the total cross section; the average level spacing was of the order of 2.4 eV. It would appear that, in this energy range, nearly all the levels were identified. The resonance parameters were determined by analysis of shape in conjunction with a least-squares programme on an IBM-7094 computer. The existence of a large number of broad resonances corresponding to very large fission widths has been shown to exist. Statistical study of the fission widths actually shows the existence of two families of resonances, one corresponding to a mean Γ_f of the order of 45 MeV and the other to a mean Γ_f of about 750 MeV. A classification of resonances in terms of two spin states was postulated, the level population ratio in each family being: $(2J_1 + 1)/(2J_2 + 1) = \frac{1}{3}$, $J_1 = 0$ corresponds to the broad resonances and $J_2 = 1$ to the narrow resonances. The partial widths for radiative capture fluctuate slightly around a mean value of 40 MeV. By using a multilevel programme, it was possible to investigate the extent to which the existence of large fission widths might give rise to fictitious resonances (quasi-resonances) and perturbations and also to make a statistical study of the resonance parameters. (auth)

18297 SPIN MEASUREMENTS OF THE 8.8-eV AND 12.4-eV NEUTRON RESONANCES IN ^{235}U. Poortmans, F.; Ceulemans, H.; Neve de Mevergnies, M. (SCK-CEN, Mol, Belg.). pp 211-15 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

Spin measurements of slow neutron resonances were done by means of the resonance scattering method, using a ^{3}He counter as the scattering detector and a crystal spectrometer as the neutron source. Results for the 8.8- and 12.4-eV resonances in ^{235}U are given and are discussed. (auth)

18298 MEASUREMENT OF THE NEUTRON CAPTURE AND FISSION CROSS SECTIONS AND OF THEIR RATIO ALPHA FOR ^{233}U, ^{235}U, AND ^{239}Pu. de Saussure, G. (Oak Ridge National Lab., Tenn.); Weston, L. W.; Gwin, R.; Ingle, R. W.; Todd, J. H.; Hockenbury, R. W.; Fullwood, R. R.; Lottin, A. pp 233-49 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

A technique was developed to measure simultaneously the neutron capture and fission cross sections of fissile nuclei. Since the two cross sections are measured simultaneously, errors associated with uncertainties in the relative energy resolution and calibration of the two measurements are eliminated. Measurements of σ_c and σ_f for ^{235}U in the neutron energy range of 3.25 to 25 eV have been published. These measurements have now been extended to cover the range of 1 to 100 eV, and the precision and energy resolution have been greatly improved. The fission cross section is in good agreement with recent measurements using different techniques. At low energy, where the instrumental resolution is small compared to the Doppler broadening and where resonance scattering is unimportant, the directly measured capture cross section is consistent over many of the resonances with that obtained indirectly by subtracting the fission and potential scattering from the total cross-section. The capture and fission resonance integrals and their ratio α_{RI}, obtained from our measurements, agree within the uncertainties with the direct integral measurements of these parameters. Further measurements on ^{235}U and ^{233}U over the neutron energy range of 1 eV to a few keV are now in progress. The limitations of the experimental method are discussed, and a detailed comparison of cross sections obtained by different techniques are presented. To compute the breeding ratio, the Doppler coefficient, and other parameters of large fast power reactors, it is important to know α, the ratio of capture-to-fission, for the main fissile isotopes, and particularly for ^{239}Pu, in the keV neutron energy region. Hopkins and Diven have performed direct measurements of α for ^{233}U, ^{235}U, and ^{239}Pu with monoenergetic neutrons at 30, 60, and above 175 keV. But the value of α for ^{239}Pu varies by more than a factor of two between

30 and 60 keV, and a detailed knowledge of the variation of this parameter with energy in the keV neutron energy range appears desirable. The application of the time-of-flight technique permits extending the direct measurements of α to energies where monoenergetic neutron sources are not readily available. Detailed measurements for α for ^{239}Pu are now in progress, at few-keV intervals in the range of 10 to 100 keV and at 100-keV intervals in the range of 100 to 600 keV. The technique has already been used with ^{235}U and the results, now published, were found in agreement with those of Hopkins and Diven in the range of overlap. The results for ^{239}Pu are compared with those of Hopkins and Diven and with values of α obtained from direct measurements of η by Spivak et al. The factors limiting the precision of the measurements are discussed in some detail. (auth)

18299 A SINGLE-LEVEL ANALYSIS OF ^{235}U BASED ON RECENT σ_t, σ_f, AND σ_c MEASUREMENTS. Drawbaugh, D. W.; Gibson, G. (Westinghouse Electric Corp., Pittsburgh). pp 251-64 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

Total, capture, and fission cross-section data were simultaneously fitted with a single-level Breit–Wigner least-squares analysis. The resonance capture and fission integrals calculated from the parameters agree within 3% with corresponding direct numerical integration of the data. The ratio of the capture resonance integral to the fission resonance integral agrees within 2% with reactor integral measurements. The effects of simultaneously fitting two cross-sections at a time (total and fission and capture and fission) were studied. (auth)

18300 OPTICAL-MODEL INVESTIGATION OF ELASTIC NEUTRON SCATTERING: HEAVY NUCLEI. Cassola, R. L.; Koshel, R. D. (Ohio Univ., Athens). Nuovo Cim. (10), 53B: 363-97(Feb. 11, 1968).

The elastic scattering of neutrons from a variety of target nuclei was analyzed for incident neutron energies between 6 and 24 MeV. At each incident neutron energy a set of optical-model parameters has been determined for each target nucleus and the mass dependence of these parameters examined. By suitably averaging the parameters found at a given energy, mass-independent optical parameters characteristic of that energy were also obtained. The average energy dependence of the optical-model parameters for neutron energies between 6 and 24 MeV was then determined on the basis of the mass-independent parameters found at the various neutron energies. Wherever possible, the results obtained in the present analysis were compared with those reported by others. For neutron scattering from target nuclei whose masses were greater than approximately 25 a.m.u. it was found that the predictions of the complex-potential model were in satisfactory agreement with the experimental data and that the potential parameters exhibited a smooth energy dependence. In particular, the depth of the real, central potential, V_c, was found to depend upon the incident neutron energy in the following manner: $V_c = 48.0 - 0.35E$ MeV. Throughout this investigation, particular attention was given to the sensitivity of the theoretical cross sections to changes in the optical-model parameters. (auth)

18301 DECAY OF ^{186}Ta. Monnand, Edouard; Blachot, Jean; Moussa, Andre (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. A and B, 265: 1054-7(Nov. 6, 1967). (In French).

^{186}Ta produced by the reaction ^{186}W(n,p)^{186}Ta was studied by direct β and γ spectrometry and by $\gamma-\gamma$ and $\beta-\gamma$ coincidences. γ rays were observed at 90, 122, 182, 197, 214, 273, 292, 307, 418, 511, 614, 706, 736, 798, 828, and 950 keV. The β spectra have two principal branches with maximum energy of 2170 ± 50 keV and 2560 ± 50 keV. The low-energy level scheme of ^{186}W was developed. (tr-auth)

18302 NUCLEAR HYPERFINE INTERACTIONS IN ^{182}W, ^{183}W, AND ^{195}Pt AS STUDIED BY THE MOESSBAUER EFFECT. Agresti, David George. Pasadena, Calif., California Inst. of Tech., 1967. 110p.

Thesis.

The Mössbauer technique was used to study the nuclear hyperfine interactions and lifetimes in ^{182}W (2^+ state) and ^{183}W ($3/2^-$ and $5/2^-$ states) with the following results: $g(5/2^-)/g(2^+) = 1.40 \pm 0.04$; $g(3/2^-) = -0.7 \pm 0.07$; $Q(5/2^-)/Q(2^+) = 0.94 \pm 0.04$; $T_{1/2}(3/2^-) = 0.184 \pm 0.005$ nsec; $T_{1/2}(5/2^-) \geq 0.7$ nsec. These quantities are discussed in terms of a rotation-particle interaction in ^{183}W due to Coriolis coupling. From the measured quantities and additional information on γ-ray transition intensities magnetic single-particle matrix elements are derived. It is inferred from these that the two effective g-factors, resulting from the Nilsson-model calculation of the single-particle matrix elements for the spin operators s_z and s_+, are not equal, consistent with a proposal of Bochnacki and Ogaza. The internal magnetic fields at the tungsten nucleus were determined for substitutional solid solutions of tungsten in iron, cobalt, and nickel. With $g(2^+) = 0.24$ the results are: $H_{eff}(W-Fe) = -715 \pm 10$ kG; $|H_{eff}(W-Co)| = 360 \pm 10$ kG; $|H_{eff}(W-Ni)| = 90 \pm 25$ kG. The electric field gradients at the tungsten nucleus were determined for WS_2 and WO_3. With $Q(2^+) = -1.81$ b the results are: for WS_2, $eq = -(1.86 \pm 0.05)\ 10^{18}$ V/cm^2; for WO_3, $eq = (1.54 \pm 0.04)\ 10^{18}$ V/cm^2; and $\eta = 0.63 \pm 0.02$. The $5/2^-$ state of ^{195}Pt was also studied with the Mössbauer technique, and the g-factor of this state has been determined to be -0.41 ± 0.03. The following magnetic fields at the Pt nucleus were found: in an Fe lattice, 1.19 ± 0.04 MG; in a Co lattice, 0.86 ± 0.03 MG; and in a Ni lattice, 0.36 ± 0.04 MG. Isomeric shifts have been detected in a number of compounds and alloys and have been interpreted to imply that the mean square radius of the ^{195}Pt nucleus in the first-excited state is smaller than in the ground state. (Disser. Abstr.)

18303 FRACTIONAL CUMULATIVE YIELDS OF ^{103}Mo, ^{105}Mo, AND ^{106}Mo FROM THE THERMAL NEUTRON FISSION OF ^{235}U. Hastings, James Donald. Columbia, Mo., Univ. of Missouri, 1967. 79p.

The fractional cumulative yields of ^{103}Mo, ^{105}Mo, and ^{106}Mo were measured from the thermal neutron fission of ^{235}U by two methods. In one, molybdenum is separated from the other members of its mass chain by precipitation of molybdenum 8-hydroxyquinolate; in the other, technetium is separated from the other members of its mass chain by precipitation of tetraphenylarsonium perrhenate (which carries the technetium). The fractional cumulative yield of each molybdenum isotope listed above was found to be 1.007 ± 0.014, 0.983 ± 0.016 and $1.065^{+0.025}_{-0.031}$, respectively. There was no evidence for the existence of fractional independent yields of ^{103}Tc, ^{105}Tc and ^{106}Tc. These measurements are not in agreement with predictions which indicate lower fractional cumulative yields for molybdenum and higher fractional independent yields for technetium. It is suggested that the enhancement of the molybdenum cumulative yields is a result of the preference for formation of isotopes of Sn from the low energy fission of ^{235}U. This same effect would also be seen in Mo, the complement of Sn from U fission. The half-life of ^{106}Mo was measured on the basis of preliminary counting data and found to be 9.5 ± 0.5 sec. (Disser. Abstr.)

18304 PROTON SCATTERING FROM HEAVY ROTATIONAL AND VIBRATIONAL NUCLEI. Slagowitz, Martin Barry. New Brunswick, N. J., Rutgers-The State Univ., 1967. 104p.

Thesis.

Systematic data on heavy rotational and vibrational nuclei were obtained. The sensitivity of the angular distribution to nuclear deformation was studied. Differential cross sections were obtained for 16 MeV protons elastically and inelastically scattered from ^{165}Ho, ^{172}Yb, ^{174}Yb, ^{176}Yb, ^{182}W, ^{190}W, ^{192}W, ^{188}Os, ^{190}Os, ^{192}Os, and Pt. The results are qualitatively compared to the predictions of coupled channel calculations. The comparisons are favorable and indicate that the transition to vibrational nuclei is not complete in ^{192}Os, but is complete in Pt. The inelastic angular distributions of protons scattered from rotational and vibrational nuclei differ more markedly than the elastic angular distributions. (Disser. Abstr.)

18305 NUCLEAR STRUCTURE OF ^{161}Dy, ^{159}Dy, AND ^{157}Dy. Bennett, Michael Johnson. Tallahassee, Fla., Florida State Univ., 1967. 107p.

Thesis.

A series of (d,p) and (d,t) reaction studies leading to the nuclei ^{161}Dy, ^{159}Dy, and ^{157}Dy is described. Each nucleus was studied by both reactions at several angles. These are all nuclei which lie in the region of transition between barely deformed and fully deformed. The experiment was designed to test the applicability of the Nilsson model in this transitional region and, in conjunction with previously published studies on the heavier Dy nuclei, to trace the systematics of the Nilsson levels throughout the Dy nuclei. A total of 20 levels was observed up to an excitation energy of 880 keV in ^{161}Dy. The following Nilsson bands were either confirmed or newly assigned: $5/2^+$ [642], $5/2^-$ [523], $1/2^-$ [521], $3/2^-$ [521], and $5/2^-$ [512]. Ground state Q values of 4.231 MeV for (d,p) reactions and −1.943 MeV for (d,t) reactions leading to the nucleus were measured. In ^{159}Dy a total of 32 levels were observed up to an excitation energy of 1.650 MeV and assignments were made or confirmed to the Nilsson orbitals with asymptotic quantum numbers $3/2^-$ [521], $5/2^+$ [642], $5/2^-$ [523], $1/2^-$ [521], and $11/2^-$ [505]. The ground state Q values are 4.608 MeV for population by (d,p) and −2.339 MeV for population by (d,t) reactions. The ^{157}Dy nucleus was studied with a total of 27 levels observed up to an excitation energy of 1.243 MeV. Band assignments were made for the $3/2^-$ [521], the $5/2^-$ [523], and the $1/2^-$ [521] Nilsson bands. The measured ground state Q values are 4.748 MeV for the ^{156}Dy(d,p)^{157}Dy reaction and −2.804 MeV for the ^{158}Dy(d,t)^{157}Dy reaction. In all of these nuclei a series of states with very high (d,t) cross sections were observed, which move downward in energy as the neutron number decreases as would be expected for hole states. Speculations were made as to the origin of these states. It is concluded that the Nilsson model explains much of the spectroscopy of these nuclei but that there are significant deviations which call for further experimental and theoretical research. (Disser. Abstr.)

Nuclear Theory

Refer also to abstracts 16884, 16959, 17197, 17387, 17753, 17803, 17833, 17890, 17891, 17926, 17927, 17941; 17960, 17974, 18101, 18117—18120, 18122, 18126, 18138, 18145, 18169, 18171, 18173, 18176, 18204, 18211, 18214, 18215, 18266, 18267, 18272, and 18300.

18306 (AECL–3007) ENUMERATION OF MANY BODY STATES OF THE NUCLEAR SHELL MODEL WITH DEFINITE ANGULAR MOMENTUM AND ISOBARIC SPIN WITH MIXED SINGLE PARTICLE ORBITS, $j = 1/2, 3/2: 1/2, 3/2, 5/2: 1/2, 3/2, 5/2, 7/2: 7/2, 3/2$. Sebe, T.; Harvey, M. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1968. 25p. Dep. CFSTI. CAN.

The number of many-body states of a given angular momentum and isobaric spin that can be formed with a given number of particles in mixed single-particle orbits is given for nuclei with $A < 60$. (D.C.W.)

18307 (JINR–D7-3548, pp 51–8) NEKOTORYE EFFEKTY OBOLOCHEK V TRANSURANOVYKH YADRAKH. (Certain Effects of Transuranium Nuclear Shells). Strutinskii, V. M.; Muzychko, Yu. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii. Joint Inst. for Nuclear Research, Dubna (USSR)). (In Russian).

The statistical or "drop" model for nuclear matter is discussed, and a comparatively simple method of microscopic calculation is suggested for shell corrections of the deformations in the model. Calculations were performed with a view of finding the minimum in large deformation. The existence of large regions of relative nuclear stability were predicted; however, predictions concerning the number of the element and its properties (fissibility, fission barrier, half-life) can not yet be predicted with the required accuracy. In spite of the universal concept that the influence of shell disappears with the nuclear γ deformation of the order of $A^{-1/3}$ (~0.2 to 0.3), it was found that with nuclear deformation appear significant characteristic condensations and rarefaction of the nuclear levels (shells) near Fermi energies which determine the equilibrate nuclear shape. In the spherical and deformed nuclei, a certain additional nuclear binding and stability energy are related to the shells. (R.V.J.)

18308 (SGAE-PH-56/1967) ZUR BESTIMMUNG DES VERHAELTNISSES C_A/C_V DURCH MESSUNG DES PROTONENSPEKTRUMS BEIM NEUTRONENZERFALL. (The Determination of the Ratio C_A/C_V by Measurement of the Proton Spectrum From Neutron Decay). Riehs, Peter (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). 1967. 11p. (In German). Dep.

The determination of the ratio C_A/C_V of beta decay coupling constants from neutron decay alone is considered in connection with a planned experiment. It appears most promising to determine the angular correlation between electron and antineutrino from the slope of the proton recoil spectrum without coincidence requirement. The deformation of the spectrum due to the thermal energies of neutrons and to the finite spectrometer resolution is estimated. (auth)

18309 (UCRL–17951) CLOSING REMARKS [OF THE] INTERNATIONAL CONFERENCE ON HYPERFINE INTERACTIONS DETECTED BY NUCLEAR RADIATION, ASILOMAR, PACIFIC GROVE, CALIFORNIA, AUGUST 25–30, 1967. Rasmussen, John O. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1967. Contract W-7405-eng-48. 5p. (CONF-670812–19). DTIE.

Some research applications of hyperfine structure measurements are briefly discussed together with the theory behind hyperfine structure. (D.C.W.)

18310 NUCLEAR STRUCTURE RESEARCH ON THE CERN ACCELERATORS. Gregory, B. P. (CERN, Geneva). pp 6-17 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

A short survey of the present CERN program is given. The survey includes the synchrocyclotron and its beams, μ-mesic and π-mesic atoms, 20-GeV proton–nuclei collisions, nuclear reactions induced by π mesons, and the use of the isotope separator on-line for the Isolde project and the study of the total production cross section of lithium from targets of variable Z. (J.F.P.)

18311 INFORMATION ON NUCLEAR STRUCTURE, DERIVED FROM ELECTRONIC, MUONIC, AND PIONIC ATOMS. Sens, J. C. (Foundation for Fundamental Research of Matter, The Netherlands. CERN, Geneva). pp 93-125 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

The main conclusions concerning nuclear structure derived from atomic spectroscopy are briefly discussed. It is shown that the entire theoretical framework of spectroscopy with electronic atoms can be carried over to spectroscopy with muonic atoms, but for an extension necessary to allow for nuclear excitation. Finally pionic atoms where the electromagnetic interactions between the meson (π) and the nucleus are largely overshadowed by the strong interaction are considered. (J.F.P.)

18312 ELECTRON SCATTERING: ELASTIC AND INELASTIC. Isabelle, D. B. (Univ. of Clermont-Ferrand, France). pp 126-42 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

The investigation of nuclear structure by electron elastic scattering, quasielastic scattering, and inelastic scattering with excitation of collective states is reviewed. The theoretical bases of such techniques are discussed together with experimental results. (D.C.W.)

18313 INTERACTIONS OF LOW-ENERGY PIONS WITH NUCLEI. Zupancic, C. (CERN, Geneva). pp 171-97 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

The use of pion reactions and scattering in investigations of nuclear structure is reviewed with consideration of the general experimental and theoretical situation. Elastic scattering, inelastic scattering, charge exchange, double charge exchange, radiative capture, and absorption are briefly discussed. (D.C.W.)

18314 NUCLEI AS ELEMENTARY PARTICLES. Primakoff, H. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). pp 409-46 of High Energy Physics and Nuclear Structure. Alexander, Gideon (ed.). New York, John Wiley and Sons, Inc., 1967.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel. See CONF-670207.

Weak interactions of nuclei, treated without any explicit consideration of the nuclei as composed of nucleons, are summarized. The weak-interaction matrix elements between the initial and final nuclear states involved are described in terms of form factors characteristic of the nuclei as wholes, the numerical values of these form factors (at the relevant momentum transfers) reflecting the complexity of the internal nuclear structure. Nuclear beta decay and meson (μ) capture, and sum rules in beta decay are covered. (J.F.P.)

18315 EFFECT OF MAGNETIC RESONANCE ON ANGULAR $\gamma-\gamma$ CORRELATION. Khaimovich, F. P. (Kazan Physico-Technical Inst., USSR). Zh. Eksp. Teor. Fiz., 54: 292-7(Jan. 1968). (In Russian).

Resonance phenomena due to the oscillating magnetic field arising during cascade emission of two γ quanta by radioactive nuclei in a weak or strong static magnetic field are considered. An expression is obtained for the correlation attenuation coefficient in the case of a weak magnetic field. It is shown that the angular correlation sharply changes upon approach to the magnetic resonance frequency. "Allowed" and "forbidden" electron paramagnetic resonance transitions resulting in resonance variation of the angular correlation are considered separately for a strong field. The phenomena may be employed for exact determination of the g factors of excited nuclear states and also as a sensitive method for detecting electron paramagnetic resonance for small concentrations of radioactive atoms. (auth)

18316 ENERGY LEVELS OF EVEN–EVEN NUCLEI WITH $I^\pi = 1^-$. Dzhelepov, B. S.; Peker, L. K. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 179-80(Jan. 1967). (In Russian).

The nature of $I^\pi = 1^-$ levels in even–even nuclei is considered in the light of the fact that they exist also in the nuclei with spherical equilibrium form in the ground state. It is suggested that in the nuclei usually considered sperical the wave functions of the state with $I^\pi = 0^+$ and $I^\pi = 2^+$ have a small admixture of the deformed state wave functions with the same spin as the 0^+ states. The nucleus with $I^\pi = 1^-$ is essentially deformed. (auth)

18317 FINITE-RANGE EFFECTS IN DISTORTED-WAVE BORN-APPROXIMATION CALCULATIONS OF NUCLEON TRANSFER REACTIONS. Sawaguri, T.; Tobocman, W. (Case Western Reserve Univ., Cleveland). J. Math. Phys. (N.Y.), 8: 2223-30 (Nov. 1967).

A method for doing distorted-wave Born-approximation calculations for nucleon transfer reactions is presented. This method is designed to be used when the zero-range approximation cannot be made. The method has the advantage that only simple quadratures need be performed. When recoil effects are negligible, the method leads to a particularly simple form. The technique developed can be applied to the evaluation of the six-dimensional integrals that result when the general two-body interaction is considered. Thus it may be usefully applied to nuclear-structure calculations when it is desired to use wave functions which are not harmonic-oscillator eigenfunctions. (auth)

18318 ABSOLUTE VALUES OF INTEGRAL CROSS SECTIONS FOR DIFFRACTION SCATTERING OF PARTICLES BY NUCLEI. Evlanov, M. V. (Physico-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 352-4(1967).

Expressions for the integral cross sections of elastic and inelastic diffraction scattering are derived. Numerical values of the ratios of the elastic and inelastic cross sections for the scattering of alpha particles by a number of nuclei are given. (D.C.W.)

18319 MATHEMATICAL CORRESPONDENCE BETWEEN THE R-MATRIX THEORY OF NUCLEAR REACTIONS AND THE ELECTROMAGNETIC THEORY OF WAVEGUIDES AND RESONATORS. Vanzani, V. (Univ., Padua). Nuovo Cim. (1), Suppl., 5: 1014-24(1967).

A quantitative formulation of the mathematical correspondence between the R-matrix theory of nuclear reactions and the theory of resonators and waveguides is outlined. (D.C.W.)

18320 BEHAVIOUR OF PROJECTED BCS SOLUTIONS AT THE CRITICAL POINT. Kissener, H. R. (Central Inst. of Nuclear Physics, Rossendorf, Ger.). Phys. Lett., 26B: 346-8 (Feb. 19, 1968).

A BCS-type solution for charge-independent ($J = 0$, $T = 1$) pairing interaction, combined with projection to states with fixed particle number and isospin is discussed for a symmetric 2-level model. The superconducting solution exists at any interaction strength; for particle numbers corresponding to filled Fermi levels, however, it does not show the correct asymptotic behavior at $G \to 0$. (auth)

18321 REACTIONS LEADING TO THE DEUTERON SINGLET STATE. Bowcock, J. E.; Gangas, N. H. (Univ., Tuebingen, Ger.). Phys. Lett., 26B: 349-50(Feb. 19, 1968).

It is shown that a comparison of pickup reactions leading to the deuteron and the virtual deuteron singlet state may give a much stricter test of stripping theories. Such reactions may also determine isotopic spin admixtures in the final state. (auth)

18322 SOLAR NEUTRINOS AND LOW-ENERGY NUCLEAR CROSS SECTIONS. Bahcall, J. N. (California Inst. of Tech., Pasadena); Bahcall, N. A.; Fowler, W. A.; Shaviv, G. Phys. Lett., 26B: 359-61(Feb. 19, 1968).

The rate of capture of solar neutrinos per ^{37}Cl atom is found to be 0.7×10^{-35} sec^{-1} and 4.9×10^{-35} sec^{-1} for two extreme assumptions regarding the measured low-energy nuclear cross secticns. The dependence of the ^{8}B solar neutrino flux on the low-energy cross-section factor for ^{3}He$(\alpha,\gamma)^{7}$Be, S_{34} is found to be $S_{34}^{0.7}$. (auth)

18323 OPTICAL MODEL ANALYSIS OF (240 TO 300) MeV K^+-MESON ELASTIC SCATTERING IN NUCLEAR EMULSION. Sood, P. M. (Panjab Univ., Chandigarh, India). Proc. Indian Acad. Sci., Sect. A, 46: 264-71(Nov. 1967).

The differential elastic scatterings of (240 to 300)-MeV mesons (K^+) in G-5 nuclear emulsions were analyzed in terms of exact diffuse-surface optical model of the nucleus and the real nuclear volume potential integral per nucleon (I_v) obtained. By making a chi square comparison between the experimental cross sections and the theoretically calculated values for the optical model parameters $R_0 = 1.07$ F and $a = 0.57$ F, I_v comes out to be (100 ± 30) MeV ^{3}F. The analysis also confirms that for K^+-nucleus scattering, repulsive potential is by far more probable than an attractive one. The K^+-free nucleon cross section was estimated to lie in the range (13.5 ± 1.7) mb. (auth)

18324 SPECTROSCOPIC INVESTIGATION OF X RADIATION INDUCED WITH RADIOACTIVE ISOTOPES. Vertes, Attila; Beck, Ivan (Eotvos Lorand Tudomanyegyetem Fizikai-Kemiai es Radiologiai Tanszeke, Budapest). Magy. Kem. Foly., 73: 492-7(Nov. 1967). (In Hungarian).

In the case of β sources of ^{14}C, the dependence of the intensity of the bremsstrahlung and characteristic x radiation on the thickness and atomic number of the absorber was studied. The thickness at which the maximum intensity of the bremsstrahlung and x radiation occurs was determined by both theoretical and experimental methods. The theoretical and experimental results gave good quantitative agreement. The atomic number at which the maximum intensity of the x radiation and the minimum intensity of the bremsstrahlung appear was also determined. The origin of these extremes was explained by resonance effects between the β electrons and the electrons of the K shell of the absorber. (tr-auth)

18325 MATRIX ELEMENTS OF THE PAIRING HAMILTONIAN FOR THE D (λ,0) REPRESENTATION OF THE R_5 GROUP IN THE (n, T, T_0) BASIS. Szpikowski, Stanislaw; Mazur-Goebel, Anna. Ann. Univ. Mariae Curie-Sklodowska, Lublin-Pol., Sect. AA, 21: 85-92(1966).

The matrix elements of the operators appearing in the pairing Hamiltonian $H = -G\{S_+^n S_-^n + S_+^p S_-^p + \frac{1}{2}S_+^{np} S_-^{np}\}$ as written in the j-$\bar{J}$ coupling approximation are given. The operators in the Hamiltonian are the generators of the transformations of the R_5 group. The construction of the basis for a given irreducible representation of the R_5 group is outlined. (D.C.W.)

18326 TENSORIAL EFFECTS IN DEUTERON ELASTIC SCATTERING. Vladuca, G. (Bucharest Univ.). Rev. Roum. Phys., 12: 337-41(1967).

The contribution of the tensorial part of the optical potential in deuteron elastic scattering is studied. It is shown that this is equivalent to the introduction of certain effective masses for which analytic expressions are found. (D.C.W.)

18327 EFFECTS OF EXCITED LEVELS ON COULOMB SCATTERING. Amai, Saburo; Miyatake, Osamu; Yoshizawa, Yasukazu (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 38: 1270-84(Dec. 1967).

It may be expected that, when excited levels of colliding nuclei are taken into consideration, some corrections to the differential cross section of the Rutherford scattering are needed. When the projectile is heavy, it is also necessary to carry out a higher order approximation for the differential cross section of the Coulomb excitation. These effects of excited levels were examined by using a perturbation expansion in quantum mechanics. For practical calculations, $_{62}$Sm^{152} is used as a target nucleus; and a spinless proton (6.05 MeV) and an oxygen ion (50 MeV) are used as projectiles. In the case of head-on collision of the spinless proton, the differential cross section for elastic scattering is decreased by about 1% in comparison with that of the Rutherford scattering. In the case of ^{16}O, the deviation from the Rutherford scattering is expected to amount to 10%. It is shown that the fundamental relation $\Sigma d\sigma_1 = d\sigma_R$ in the semi-classical theory (SCT) holds with good accuracy in the case of proton bombardment. A quantum-mechanical expression for the reorientation effect in the Coulomb excitation is also derived in the second-order approximation. Among those terms which are contained in the excitation cross section, a term, which is proportional to the product of the wave number of the projectile and the quadrupole moment of the first excited state, is the most effective one for the reorientation. Although comparison of the present results with those obtained by the SCT has not yet been made, analysis of experimental data seems to indicate inadequacy of the application of the SCT in higher order approximations. (auth)

18328 A REALISTIC THOMAS-FERMI APPROACH TO FINITE NUCLEI. Brink, David M.; Peierls, Rudolf E. Comments Nucl. Particle Phys., 2: 28-32(Jan.-Feb. 1968).

An approach, proposed by Bethe, to the description of finite nuclei is summarized, in which the short-range and long-range parts of the potential are treated separately. A local-density approximation is used for the short-range interaction, leading to an effective interaction, or reaction matrix, that is strongly density dependent but is not appreciably dependent on the relative velocity of the two nucleons. The tensor contribution to the long-range part of the potential is replaced by an effective central force that is density independent and has the same radial dependence as the direct central force. (D.C.W.)

18329 THOMAS-FERMI THEORY OF NUCLEI. Bethe, H. A. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 167: 879-907 (Mar. 20, 1968).

A Thomas–Fermi theory of large, finite nuclei is developed. Realistic nuclear forces with repulsive core are assumed, and maximum use is made of the theory of nuclear matter. Simplifications are introduced wherever permissible. The local-density approximation with a certain correction is found to be valid. Tensor forces are replaced by a density-dependent, effective central force, the repulsive core by a density-dependent δ-function interaction. The Thomas-Fermi expression for kinetic energy is shown to be good whenever the density is at least 17% of nuclear-matter density; under the same conditions, the Slater approximation to the mixed density $\rho(r_1,r_2)$ is valid. From the total energy of the nucleus, an integral equation is derived for the density $\rho(r)$. This is approximated by a differential equation which is solved analytically. The resulting density distribution has both similarities with and differences from the conventional, Fermi-type distribution. Our density agrees as well with electron-scattering experiments as the Fermi-type does. The thickness of the nuclear surface comes out about 10% too large from our theory; the surface energy is in good agreement with the semi-empirical value. So far, the number of neutrons and protons has been assumed equal, and the Coulomb force has been neglected. (auth)

18330 PARTIAL-WAVE ANALYSIS OF INELASTIC ELECTRON SCATTERING ON THE COLLECTIVE GIANT RESONANCES OF MEDIUM AND HEAVY SPHERICAL EVEN NUCLEI. Tuan, S. T. (Duke Univ., Durham, N. C.); Weber, H. J.; Wright, L. E. Phys. Rev., 167: 939-56(Mar. 20, 1968).

A partial-wave analysis of inelastic electron scattering on the giant (isospin) resonance is carried out for even medium and heavy spherical nuclei, taking into account the effects of finite energy loss. The giant resonance is treated collectively (Steinwedel-Jensen two-fluid model) by the dynamic coupling of the Goldhaber-Teller dipole mode to the collective quadrupole surface oscillations. The effects on the inelastic electron cross section due to the coupling of the surface phonons with their associated transition charge to the dipole modes are investigated. Since no experimental results are available yet, the electron scattering cross sections for several nuclei are calculated and are compared with the predictions of the pure dipole-mode model and the Born approximation. The nuclear parameters used are determined by fitting the photoabsorption cross section to experiment. (auth)

18331 GRAPH OF CURIES VERSUS HALF-LIFE FOR ALL RADIONUCLIDES. Kelley, H. M. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Health Phys., 14: 271-2(Mar. 1968).

In its usual form, the equation for the specific activity of a radionuclide is an inverse function of both the half-life and the atomic weight, since specific activity requires a different number of atoms for every nuclide. By changing the dependent variable from specific activity to activity (disintegration rate) per gram atomic weight the equation specifies the same number of decaying atoms for any nuclide, and the disintegration rate is inversely proportional to half-life alone. A single linear log-log plot relates decay rate and time, and calculation of specific activity for all radionuclides is facilitated. A graph is presented showing this relation, with three overlapping scales from 10^{-3} to 10^{6} yr and from 10^{8} to 10^{-1} Ci/g atomic weight. In order to obtain specific activity the disintegration rate of a nuclide, obtained from the graph, is merely divided by the atomic weight. (UK)

18332 KINETIC ENERGY OF FISSION FRAGMENTS. Cherdantsev, P. A.; Marshalkin, V. E. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 9, 34-9(1967). (In Russian).

The Coulomb energy of nuclear fission (in a general asymmetric case) into two spherical fragments and ellipsoidal deformation was calculated. The shape of the nucleus during symmetric fission, at the moment of scission, and its effects on the kinetic energy of the fragments were found. (tr-auth)

18333 INELASTIC SCATTERING OF COMPLEX NUCLEI ACCOMPANIED BY THE EXCITATION OF COLLECTIVE STATES. Grabowski, J.; Kalinkin, B. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Proc. Phys. Soc. (London), 92: 909-11(Dec. 1967).

The relation between the Coulomb and nuclear excitation of collective and one-particle levels in the inelastic scattering of complex nuclei was estimated in the energy region above the Coulomb barrier. It is shown that for heavy ions and medium and heavy target nuclei, about 90% of the inelastic scattering cross section for E2 transitions is due to the Coulomb excitation. Estimates of the E3 transition inelastic scattering cross section for three different nuclei were also made. (auth) (UK)

18334 MULTIPLY CHARGED FRAGMENTS IN RELATIVISTIC NUCLEUS-NUCLEUS COLLISIONS. Otterlund, I.; Andersson, B. (Lund Univ., Sweden. Inst. of Physics, Lund, Sweden). Ark. Fys., 35: 133-47(1968).

Multiply charged fragments emitted from the projectile nuclei in eighty-eight nucleus-nucleus collisions produced in nuclear emulsions by heavy cosmic-ray primaries were studied. The charge of the projectile nuclei falls in the interval $3 \le Z \le 26$ and the threshold kinetic energy was about 1.7 GeV/nucleon. The angular distribution of alpha particles emitted from the projectile nuclei were studied and compared with the distribution to be expected if the alpha-particles are produced in an evaporation process from the excited fragments of the projectile nuclei. From this analysis, it was found that the distribution of most of the alpha particles was consistent with the evaporation theory. A small percentage of them was, however, split from the incident nuclei with such large angles in the laboratory system that it was unreasonable to assume that they were produced in an evaporation process. The mean angle of the evaporation alpha particles in the shower does not depend very much on the number of nucleons involved in the interaction. From the azimuthal distribution of the alpha particles and from the angular distribution of the heavy fragments, it is concluded that the fragments have a recoil component in the transverse direction to the incident nucleus. (auth) (Sweden)

18335 SHELL-MODEL SEMI-EMPIRICAL NUCLEAR MASSES II. Zeldes, N.; Grill, A.; Simievic, A. Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Skr., 3: 163p(1967).

The mass table used in part I is revised by using more recent experimental data. Nuclear structure effects previously revealed by second- and third-order mass differences are re-examined and confirmed with the help of the newer data. The previously developed semi-empirical shell-model mass equation is further elaborated and represents nuclear masses beyond the 1 p shell with an accuracy of about 170 keV. Some remarks concerning the liquid-drop model mass equation are made. A table of calculated masses is appended. (auth)

18336 SPECTROSCOPIC FACTORS FROM ISOBARIC ANALOG RESONANCES IN ELASTIC PROTON SCATTERING. Harney, H. L.; Wiedner, C. A.; Wurm, J. P. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett., 26B: 204-6(Jan. 22, 1968).

A method for obtaining spectroscopic factors from isobaric analog resonances in proton elastic scattering is proposed. The method is based on a solution of Lane's equations in the framework of Feshbach's theory of resonance phenomena. The spectroscopic factors from proton scattering are compared with those from corresponding (d,p) experiments for several states in ^{139}Ba, ^{141}Ce, ^{143}Nd, ^{147}Nd, and ^{145}Sm. (D.C.W.)

18337 AMPLITUDE SINGULARITIES IN TWO-PARTICLE NUCLEAR REACTIONS. Dubovoi, E. I. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 240-2(Oct. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 777-80(Oct. 1, 1967).

In a number of experimental papers the energy dependence of the differential cross sections for the reactions ^{3}He(n,p)T, T(p,p)T, T(p,γ)^{4}He, T(p,n)^{3}He, ^{3}He(n,n)^{3}He, and ^{4}He(γ,p)T reveals resonances that are interpreted as corresponding to excited states in the compound nucleus ^{4}He. These resonances have widths on the order of 1 MeV and lie in the excitation energy region 20 to 30 MeV. It is shown that a triangular Feynman diagram yields a number of resonances in the differential cross section of the $A + x \to B + y$ reaction. Their widths are of the order of 2 to 5 MeV, and their position does not depend on the scattering angle. The height of the resonances depends strongly on the presence in the reaction amplitude of terms corresponding to other diagrams, that depend on the emission angle of the reaction products and vary slowly with the initial energy. In the case of the above reactions, the resonances determined by the Feynman diagram lie at initial energies (in the c.m. system) that coincide with the position of the hypothetical levels in ^{4}He. (S.F.L.)

18338 APPLYING PREDICTION ANALYSIS TO THE MEASUREMENT OF HALF-LIFE. Wolberg, J. R.; Hetsroni, G. (Technion-Israel Inst. of Tech., Haifa). Nucl. Appl., 4: 187-9 (Mar. 1968).

Prediction analysis is applied to the design of experiments for measuring the half-life of a radioactive species. The half-life is assumed to be determined by fitting the exponential-plus-background function to the data points. Results can predict the experimental accuracy to which the half-life will be determined in a proposed experiment. The predicted accuracy is a function of the number of data points, the range of time values, the initial count rate, the amplitude-to-background ratio, and the uncertainties (in the time value as well as in the counts per channel) associated with each data point. (auth)

18339 ENERGY AND CHARGE DISTRIBUTION IN THE THERMAL NEUTRON-INDUCED FISSION OF ^{235}U AND THE SPONTANEOUS FISSION OF ^{252}Cf. Kluge, Gyula; Lajtai, Albert. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 16: 45-51(1968). (In Hungarian).

The total energy released per fragment pair was evaluated for the thermal-neutron fission of ^{235}U and the spontaneous fission of ^{252}Cf using the Myers-Swiatecki mass formula. The total charge distribution was determined by localizing the maximum energy release. The results are compared with those predicted from other mass formulas as well as with other reported experimental and theoretical values. (auth)

18340 FINITE SIZE EFFECTS IN THE TWO-NUCLEON TRANSFER REACTIONS. Imanishi, Bunryu (Nihon Univ., Tokyo). Progr. Theo. Phys. (Kyoto), 38: 1095-1108 (Nov. 1967).

For the two-nucleon transfer reactions, the effects of finite size size of the transferred system in the light incident particle are investigated. It is shown that the transitions of the two-nucleon system to the residual nuclear states which are not cluster-like are not necessarily negligible although they have often been neglected in the actual calculations. According to the calculations the transition amplitudes are more sensitive to the choice of the size parameter of the transferred system than those for the cluster like states are. Therefore, in studying the reactions with such a residual nucleus in which the nucleon pairs are destroyed, one should carefully treat the spatial extension of the system in the final and initial channels. As one of the effects of the finiteness, it is also pointed out that the effect of the tail of the bound-state wave function is more important in the two-nucleon transfer reactions than in the (d,p) or (d,n) reaction. Numerical calculations are carried out by choosing the reaction ^{16}O(α,d)^{18}F as an example. (auth)

18341 ON THE POSSIBLE EXPLANATION OF THE ENERGY GAP INCREASE IN FISSIONING NUCLEI. Stepien, W.; Szymanski, Z. (Univ. of Warsaw). Phys. Lett., 26B: 181-3(Jan. 22, 1968).

An assumption is introduced that the pairing force strength G in nuclei varies proportionally to the magnitude of the nuclear surface. This possibly explains the increase in the energy gap of the fissioning nuclei at their saddle-point. (auth)

18342 HIGHER-ORDER CORRECTIONS TO COLLECTIVE PARTICLE-HOLE EXCITATIONS USING GREEN FUNCTION TECHNIQUES. Barrett, B. R. (Stanford Univ., Calif.). Nucl. Phys., A109: 129-45 (1968).

Using Green function techniques, the higher-order corrections to the Tamm – Dancoff and Random Phase Approximation equations are determined. In particular, it is found that the second-order corrections to the Tamm – Dancoff equations consist of a t-matrix term and a core-polarization term. If the configuration space is truncated, an additional second-order correction from the particle-hole ladder term is obtained. Numerical calculations of these second-order corrections are carried out for the negative-parity excited states of ^{4}He using the Tabakin separable potential. (auth)

18343 NUCLEAR PHOTON SCATTERING. Silbar, R.; Uberall, H. (Univ. of America, Washington, D. C.). Nucl. Phys., A109: 146-62 (1968).

The theory of nuclear photon scattering, which was first presented by Placzek and Fano for electric dipole transitions and extended by Arenhövel to electric quadrupoles, is derived in a general fashion for all electric and magnetic multipoles. The results are written in terms of dynamical quantities ("nuclear polarizabilities," expressed by the same nuclear current and magnetization reduced matrix elements that also enter into the theory of photo- and electro-excitation), and of kinematical factors expressed by Racah coefficients. All photon and nuclear polarization effects are included in the results. Electric and magnetic dipoles are considered in detail as special cases. The long wavelength limit is contained in our formulae only implicitly and can be obtained in the form of a Thomson (scattering by the nuclear charge as a whole) and a Rayleigh limit (internal excitations) after separating out the relative-coordinate terms from the A^2 part of the amplitude and combining them with the $(j \cdot A)^2$ part, as shown in a previous publication for electric dipoles. (auth)

18344 THE ATOMIC SCREENING IN INTERNAL L-CONVERSION CALCULATIONS. Pauli, Hans-Christian (Univ. of Copenhagen. Institut fuer Theoretische Physik, Basel). Nucl. Phys., A109: 94-104 (1968).

Three different problems connected by the theory of internal conversion are discussed. (i) The influence of the atomic screening of the wave functions on the bound and free electrons as well as on the internal conversion coefficients is discussed. A semi-empirical procedure is suggested, which includes more or less correctly the screening effects in atomic calculations. (ii) The effective Coulomb field and its limits are discussed for the M-shell. (iii) New theoretical M/L total shell ratios of internal conversion are presented, where screening is taken into account. The semi-empirical rule that the total M/L shell ratios are about 0.3 up to a factor of two is verified numerically. (auth)

18345 INFLUENCE OF THE RADIATIVE BACKGROUND ON MUON AND ELECTRON SCATTERING FROM NUCLEI. Maximon, L. C. (National Bureau of Standards, Washington, D. C.); Tzara, C. Phys. Lett., 26B: 201-3(Jan. 22, 1968).

The influence of radiative tails and radiative corrections to inelastic scattering on nuclei at low excitation is compared for muons and electrons. It is found that only for low momentum transfers $Q \lesssim 50$ MeV/c is the radiative background substantially less for muons than for electrons. (auth)

18346 A NOTE ON THE SU$_3$ COUPLING COEFFICIENTS IN THE 2s-1d SHELL. Sebe, T. (Chalk River Nuclear Labs., Ont. Hosei Univ., Tokyo). Nucl. Phys., A109: 65-80 (1968).

Algebraic expressions are given for the SU$_3$ Clebsch – Gordan coefficients for the coupling of a single particle of the oscillator 1p or (2s, 1d) shells to a general state in the classification scheme according to SU$_3$ and R$_3$. Algebraic expressions for the $(n-1|\}n)$ fractional parentage coefficients for the particular SU$_3$ representations $(\lambda\mu)$ with $\lambda + 2\mu = 2 \times$ (number of particles in the (2s, 1d) shell) are shown to be the same as those for the SU$_3$ Clebsch – Gordan coefficients in the oscillator 1p shell. (auth)

18347 CALCULATION OF NUCLEAR CROSS SECTIONS BY THE OPTICAL MODEL. Goldman, D. T. (National Bureau of Standards, Washington, D. C.). pp 339-65 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.1); CONF-661014-(Vol.1).

A systematic derivation of nuclear cross sections is presented beginning with the interaction between an incident particle and the target nucleons. The replacement of the exact potential by an effective potential results, to first order, in the ordinary time-independent Schrödinger equation. This equation, including a complex and spin-orbit potential is solved for the resultant wave function. By writing the wave function in its scattering solution form, it is possible to compute the shape elastic cross section and the polarization directly in Legendre moment expansions. The compound-nucleus cross section, as given originally by the statistical model of Hauser and Feshbach, arises naturally by examining the total wave function. By using the entire solution, including the complete interaction potential, it is possible to generalize these calculations to include the effect of nonspherical potentials and to derive the distorted-wave Born approximation. The equations derived in this manner have been used in writing ABACUS-1 and OPTIC, two widely utilized optical model programmes developed at Knolls Atomic Power Laboratory. The results obtained from calculations with suitably adjusted potential parameters, have provided confidence for further use of these optical model techniques in providing cross-section information. (auth)

18348 EFFECT OF VARIATIONS IN THE ENERGY AND MASS DISTRIBUTIONS OF FISSION FRAGMENTS ON ENERGY DEPENDENCE. Kuz'minov, B. D.; Sergachev, A. I.; D'yachenko, P. P.; Vorob'eva, V. G.; Senchenko, V. I.; Tarasko, M. Z. (Inst. of Physics and Energetics, Obninsk, USSR). pp 85-8 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

The average number of neutrons emitted in a single fission event is determined mainly by the excitation energy of the fragments. It has been shown in a number of studies that an increase in the excitation energy of a fissionable nucleus is usually accompanied by an increase in the number of fission neutrons. The quantity $\bar{\nu}$ being measured is an average for all the fragment masses. When there is a change in the excitation energy of a nucleus undergoing fission, the yield and the kinetic energy of the fragments also change, so that these factors have an effect on the value of $\bar{\nu}$. One can then write $\bar{E}_{excit.} = \int E_{fiss.}\, Y(M)dM - \int E_{kin.} Y(M)dM + E_n + B_n$ or, approximately, $\Delta\bar{\nu} = a[\overline{\Delta E}_{fiss.} - \overline{\Delta E}_{kin.} + \Delta E_n]$. The effect of changes in the kinetic energy and yield of fragments in fast-neutron fission of ^{233}U, ^{235}U and ^{238}U on the energy dependence of $\bar{\nu}$ for neutron energies in the range 0 to 7 MeV is discussed. Information is obtained regarding the kinetic energy and yield of fragments by simultaneous measurement (with semiconductor detectors) of the kinetic energies of fragment pairs. It is shown that the changes in the average kinetic energy and yield of fragments of different mass, which have been observed in many cases, can make an appreciable contribution to the change in $\bar{\nu}$ (auth)

18349 INTERPRETATION OF NEUTRON-INDUCED FISSION CROSS SECTIONS AND RELATED DATA. Lynn, J. E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 89-115 of Nuclear Data for Reactors. Vienna, International Atomic Energy Agency, 1967.

From IAEA Conference on Nuclear Data, Paris. See STI/PUB-140(Vol.2); CONF-661014-(Vol.2).

The interpretation of the slow neutron cross sections, ratios of capture-to-fission cross sections in the keV region, and degree of asymmetry in the mass distribution of fission products in the framework of the channel theory of fission is discussed. Problems associated with the fission cross sections of even nuclei are mentioned, and a new hypothesis concerning the behavior of mean fission widths is advanced as a possible solution. (auth)

18350 NUCLEAR DISTORTION EFFECTS ON NUCLEONS EMITTED BY PION ABSORPTION. Sakamoto, Y. (Institut de Physique Nucleaire, Orsay, France). Nuovo Cim. (10), 53B: 433-42(Feb. 11, 1968).

Nuclear distortion effects are investigated for the absorption rate of pions by nucleon pairs in light nuclei, accompanied by the emission of the pairs. The WKB method is used for taking account of the distortion effects on the emitted nucleons. The real part of the optical potential in the distortion factor does not play an important role as far as the integrated absorption rate concerned. (auth)

18351 ON THE K-CONVERSION COEFFICIENTS OF M1 TRANSITIONS IN ODD-MASS NUCLEI. Ramaswamy, M. K. (Fordham Univ., Bronx, N. Y.). Nuovo Cim. (10), 53B: 280-2 (Feb. 11, 1968).

In view of the recent observation that even l-allowed M1 transitions can be retarded, a study is made of the K-conversion coefficients of odd-mass spherical nuclei. Certain anomalies are pointed out. (auth)

18352 SQUARE-WELL GENERALIZED OPTICAL MODEL. Pisent, G.; Zardi, F. (Univ., Padua). Nuovo Cim. (10), 53B: 310-28(Feb. 11, 1968).

The interaction of neutrons with collective even-even nuclei is discussed on the basis of the generalized optical model. The spin-orbit coupling and both the surface and volume absorbtion terms are taken into account. By assuming a square-well radial interaction and by introducing the elastic-channel logarithmic derivative, the effects of virtual and real excitation of the first 2^+ level on the cross sections are deeply analyzed. Particular interest is devoted to the behavior of the cross sections in the zero-energy limit, at threshold, and in the limit of very weak coupling. In particular, the analysis of the last point allows one to derive some general and interesting properties of the intermediate structures, by considering the growing up of the collective spectrum over the single-particle background, as far as the coupling with the 2^+ level is gradually switched on. (auth)

18353 VALIDITY OF THE RANDOM PHASE APPROXIMATION FOR PAIRING VIBRATIONS OF CLOSED-SHELL NUCLEI. Kleber, M. (Technische Hochschule, Munich). Z. Phys., 210: 251-8(1968).

The RPA method is applied to two kinds of Hamiltonians. First, the pairing force Hamiltonian for two levels is considered. The RPA ground-state energy lies below the actual energy, whereas the RPA excitation energies are too small. In the case of a more realistic Hamiltonian, a potential strength is chosen for which the RPA reproduces the 6.06-MeV 0^+ level of O^{16}. By comparison with the (variational) FBCS approximation, it is seen that the RPA ground-state energy again lies considerably below the variational value. The RPA ground-state wave function is calculated. It is shown that the quasi-boson approach of the RPA enhances the spread of the Fermi level. The enhancement is proved to become singular when the RPA breaks down. Finally, the class of possible RPA ground-state wave functions is discussed. (auth)

18354 COMPLEX γ-SPECTRUM DECOMPOSITION BY MEANS OF THE GENERAL PURPOSE CONTROL COMPUTER DNIEPER. Yamnitskii, V. A.; Kopanets, E. G.; Korda, Yu. S.; Tsytko, S. P.; Zeidlits, P. M. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 1989-99(Dec. 1967). (In Russian).

The method is presented for decomposition of complex γ-spectra by means of the Dnieper computer. It is based on the principle of γ-spectrum decomposition by standard γ-line forms. There are three ways of carrying out this analysis. The first way is based on the fact that the standard line photopeak has a steep descent in the direction of greater energies. This method of decomposition is called amplitude decomposition. The second method, area decomposition, is based on equaling the area under the peak, corresponding to the maximum energy, to the area under the photopeak of the maximum energy line. The second way gives better results and is applied as specification of the first type decomposition. The third method of decomposition with the minimization of the residual spectrum, based on the former two ways, consists of the fact that the sum of the squares of the residual spectrum amplitudes (after substracting all the standard lines) is assumed to be some functional, the minimization of which is necessary to be found by the variation of the amplitudes of separate lines. The problem is solved by the method of the descent by coordinates. (auth)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 16735, 16740, 16753, 17093, and 17190.

18355 (ACNP-64546) REPORT ON THE FULL POWER OPERATION OF THE ELK RIVER BOILING WATER REACTOR. Diaz, A.; Kintner, L. L.; MacKay, S. D.; Thie, J. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). June 1964. Contract AT(11-1)-654. 76p. Dep. CFSTI.

The power escalation of the Elk River Reactor was resumed on February 1, 1964. The power was increased from 40% to 100% of full power between February 1 and February 11. During the power escalation, tests were performed at 60, 80, 90, and 100% power. Power operation continued through February 14, and then the reactor was shut down for minor repairs on superheater equipment. The 28-day warranty run was begun on February 17 and continued uninterrupted through the month of February. Several scrams were experienced in March, but the operation was resumed, and the 28-day warranty run was completed successfully on March 20, 1964. The plant was shut down on March 21, 1964, and some additional data were gathered during the shutdown. That the reactor could be operated within the previously established safety criteria was verified by the testing performed during the power escalation and 28-day run. The reactor noise analysis indicated no loss of stability with increasing power level, and the sharpness of the most resonant frequency was always greater than 0.1 $\Delta f/f$. The measured reactivity in voids increased in the manner expected and the power coefficient was measured as 9¢ per MW between 40 and 100% power. Although the subcooling decreased as a function of power, it was measured at full power to be at least 0.2°F. Full withdrawal of 12 of the 13 rods was necessary to achieve full power. This withdrawal caused the axial power peak to be minimized, thereby providing ample heat flux margin. Although the reactor was operated throughout the warranty run without off-gasing the primary system, no combustible concentration of radiolytic gases was accumulated in any major volume in the primary system. The data taken during the power escalation and 28-day run are presented and analyzed. (auth)

18356 (BAW-3867-2) FAST BREEDER REACTOR STATIC PHYSICS METHODS DEVELOPMENT AND ANALYSIS PROJECT. Quarterly Technical Report, October–December 1967. Roy, D. H.; Helholtz, J.; Livolsi, A. Z. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). Feb. 1968. Contracts AT(30-1)-3867; 859-3105. 27p. Dep. CFSTI.

The development and utilization of a design-oriented, one-dimensional criticality and depletion code applicable to the physics analysis of fast reactors are discussed. The code development program includes: execution of MC^2 by using an ETOE generated library; the programming initiated for RETAP routine; the adaption of free-format input subroutines for use by FARED; and the specifications of FARED control, edit, and depletion routines. (D.C.C.)

18357 (BNWL-597) MULTIPLEXER CODES FOR THE PDP-7. Wilburn, N. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1968. Contract AT(45-1)-1830. 91p. Dep. CFSTI.

A small digital computer (PDP-7) has been interfaced to a low-speed relay multiplexer (2000 points/sec) and a high-speed solid-state multiplexer (240,000 points/sec). The three codes which have been written to operate these multiplexers and to record the data collected onto magnetic tape, are described. (auth)

18358 (CEND/PRWRA-270) BOILING NUCLEAR SUPERHEATER (BONUS) POWER STATION. BONUS PREOPERATIONAL ANALYSIS REPORT. Gerken, W. W. (Combustion Engineering, Inc., Windsor, Conn. Puerto Rico Water Resources Authority, San Juan). June 1966. Contracts AT(40-1)-2674; AT(40-1)-2672. 410p. Dep. CFSTI.

The BONUS reactor achieved initial criticality on April 13, 1964, and on December 19, 1965, the startup phase of operations was completed after a full power demonstration run. Experiments conducted in the intervening time to fulfill the requirements of the preoperational analysis program are presented. A relatively large number of core configurations were tested and analyzed to establish their nuclear, thermal, and control characteristics. The core configurations studied under cold critical conditions were: a 6 × 6 boiler assembly without boiler shims, a 6 × 6 boiler assembly with boiler shims, an 8 × 8 boiler assembly with boiler shims, a reduced BONUS core, and a full BONUS core. Extensive tests under hot operating power conditions were conducted on the 8 × 8 boiler core, the reduced superheater core, and the full BONUS core to evaluate their nuclear control and thermal characteristics during steady-state and transient operating modes. (H.D.R.)

18359 (DLCS-5000467) QUARTERLY OPERATING REPORT [OF SHIPPINGPORT ATOMIC POWER STATION], FOURTH QUARTER, 1967. (Duquesne Light Co., Shippingport, Pa. Power Stations Dept.). Contract AT(11-1)-292. 24p. Dep. CFSTI.

Topics discussed include: summary of Core 2 performance; graphical display of reactor power output; fission product monitoring analysis; water coolant chemical analysis; refueling program; maintenance; and testing program. (D.C.C.)

18360 (DOCKET-50244-1) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. INTRODUCTION AND SUMMARY; DESCRIPTION OF SITE AND ENVIRONMENT; PLANT DESIGN DESCRIPTION. Final Facility Description and Safety Analysis Report, Amendment 6, Exhibit D-5, Vol. 1. (Rochester Gas and Electric Corp., N. Y.). Jan. 24, 1968. 835p. Dep. CFSTI.

Information on the Robert Emmett Ginna Power Reactor, Unit 1, is given under the following broad topics: Introduction and Summary; Site and Environment; Reactor; Reactor Coolant System; and Containment System. (M.L.S.)

18361 (DOCKET-50244-2) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. PLANT DESIGN DESCRIPTION AND SAFETY ANALYSIS. Final Facility Description and Safety Analysis Report, Amendment 6, Exhibit D-5, Vol. 2. (Rochester Gas and Electric Corp., N. Y.). Jan. 24, 1968. 818p. Dep. CFSTI.

Information on the Robert Emmett Ginna Power Reactor, Unit 1, is given under the following broad topics: Engineered Safety Features including the safety injection system, containment ventilation system, and containment spray system; Instrumentation and Controls; Electrical System; Auxiliary and Emergency Systems; Steam and Power Conversion System; Radioactive Waste and Radiation Protection; Conduct of Operations; Initial Tests and Operation; and Safety Analyses including core and coolant boundary protection analyses, standby safety features analysis, blowdown analyses, and turbine generator unit failures. (M.L.S.)

18362 (DOCKET-50267-1) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. [Preliminary Safety Analysis Report], Amendment 10. (Public Service Co. of Colorado, Denver). Feb. 12, 1968. 344p. Dep. CFSTI.

Miscellaneous revision pages to answers submitted in previous amendments are included; supplementary information on the core heatup accident is given. Information on seismic damping values and prestressed concrete reactor vessel design is included; design changes on control systems and instrumentation are described. A comparison of the Fort St. Vrain Plant Design with the General Design criteria of 32FR10213 is made. (M.L.S.)

18363 (DOCKET-50272-1) SALEM NUCLEAR GENERATING STATION (FORMERLY BURLINGTON NUCLEAR GENERATING STATION). Preliminary Facility Description and Safety Analysis Report, Amendment 3, Part B, Vol. 1. (Public Service Electric and Gas Co., Newark, N. J.). Jan. 22, 1968. 460p. (DOCKET-50311-1). Dep. CFSTI.

Information on Salem Power Reactor, Units 1 and 2, is given in the following major areas: Summary Description; Site and Environment; Reactor; Reactor Coolant System; and Containment System. (M.L.S.)

18364 (DOCKET-50272-2) SALEM NUCLEAR GENERATING STATION (FORMERLY BURLINGTON NUCLEAR GENERATING STATION). Preliminary Facility Description and Safety Analysis Report, Amendment 3, Part B, Vol. 2. (Public Service Electric and Gas Co., Newark, N. J.). Jan. 22, 1968. 413p. (DOCKET-50311-2). Dep. CFSTI.

Information on Salem Power Reactor, Units 1 and 2, is given under the following broad topics: Engineered Safety Features including Emergency Core Cooling System (ECCS), containment spray system, containment isolation system, and containment ventilation system; Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion System; and Radioactive Wastes and Radiation Protection. (M.L.S.)

18365 (DOCKET-50272-3) SALEM NUCLEAR GENERATING STATION (FORMERLY BURLINGTON NUCLEAR GENERATING STATION). Preliminary Facility Description and Safety Analysis Report, Amendment 3, Part B, Vol. 3. (Public Service Electric and Gas Co., Newark, N. J.). Jan. 22, 1968. 602p. (DOCKET-50311-3). Dep. CFSTI.

A safety evaluation—including core and coolant boundary protection, standby safeguards analysis, and blowdown analysis—is given. Detailed results of studies on meteorology and site environment are given. Seismic design criteria for structures and equipment are outlined; pressure vessel NDTT calculations are described. Trip channels are described in detail; schematics are shown. Reactor protection systems are discussed. Performance ability of the guaranteed power supply, under emergency conditions, is evaluated. Functions of the containment ventilation and containment spray systems under varying hypothetical accident conditions are analyzed. Use of sodium thiosulfate as a containment spray for iodine removal is discussed. Diagrams are given for all containment penetrations. Coolant loss accidents are analyzed in detail; curves of reactor vessel pressure and water level and level transients are shown. Post coolant loss accident energy release is considered in detail. (M.L.S.)

18366 (DOCKET-50272-4) SALEM NUCLEAR GENERATING STATION (FORMERLY BURLINGTON NUCLEAR GENERATING STATION). Preliminary Facility Description and Safety Analysis Report, Amendment 3, Part B, Vol. 4. (Public Service Electric and Gas Co., Newark, N. J.). Jan. 22, 1968. 358p. (DOCKET-50311-4). Dep. CFSTI.

Load combination criteria and stress intensity limits are discussed with respect to the Class I equipment for Salem Power Reactor, Units 1 and 2. The design of the steam line isolation valves and their leakage characteristics are described. Core DNB ratios are tabulated; stress amplitudes for plant transients are listed. Methods used for calculation of neutron fluxes at monitor samples in the containment vessel are described. Design leakage rates for valves located outside containment upstream of steam isolation valves are tabulated. Core loading diagrams are given; results of fuel temperature calculations are shown graphically. Core and containment cooling is discussed. Effects of a superheated containment atmosphere on heat removal are detailed. Details concerning the sodium thiosulfate spray system are given. The emergency power supply is discussed. Results of a double ended failure of the largest primary coolant pipe are given; integrated energy release to the containment is given as a function of time. A hypothetical steam line break accident is analyzed in detail. The model used for calculating fission product inventory is discussed; results of calculations are detailed. Detailed information on xenon oscillations is given. (M.L.S.)

18367 (DOCKET-50272-5) SALEM NUCLEAR GENERATING STATION. [Preliminary Facility Description and Safety Analysis Report], Amendment 4. (Public Service Electric and Gas Co., Newark, N. J.). Feb. 12, 1968. 20p. (DOCKET-50311-5). Dep. CFSTI.

The quality control program for the Salem Power Reactors, Units 1 and 2, is detailed. (M.L.S.)

18368 (DOCKET-50275-1) PACIFIC GAS AND ELECTRIC COMPANY, DIABLO CANYON NUCLEAR POWER PLANT: SAFETY EVALUATION. (Division of Reactor Licensing (AEC), Washington, D. C.). Jan. 23, 1968. 96p. Dep. CFSTI.

A safety evaluation of Diablo Canyon Power Reactor was performed by the AEC, Division of Reactor Licensing; results are given. Containment and emergency cooling systems were evaluated for 3391 MWt; thermal and hydraulic characteristics were evaluated at 3250 MWt. Subjects pertaining to the Diablo Canyon Power Reactor which are discussed with varying emphasis are: site, system design, containment, engineered safeguards, design of Class I structures for seismic and accident loading, and accident analyses. (M.L.S.)

18369 (DOCKET-50275-2) NUCLEAR PLANT, DIABLO CANYON SITE. Preliminary Safety Analysis Report, Vol. 1. (Pacific Gas and Electric Co., San Francisco, Calif.). Jan. 18, 1967. 370p. Dep. CFSTI.

Information on Diablo Canyon Power Reactor is included under the following broad topics: Summary Description; Site and Environment including meteorology, hydrology, geology, seismology, oceanography, and environmental radioactivity studies; Reactor; Reactor Coolant System; Containment System; Engineered Safeguards including the safety injection system, containment spray system, containment ventilation system, and containment isolation system; and Plant Instrumentation and Control. (M.L.S.)

18370 (DOCKET-50275-3) NUCLEAR PLANT, DIABLO CANYON SITE. Preliminary Safety Analysis Report, Vol. 2. (Pacific Gas and Electric Co., San Francisco, Calif.). Jan. 18, 1967. 350p. Dep. CFSTI.

Information on Diablo Canyon Power Reactor is included under the following broad topics: Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion System; Radioactive Wastes and Radiation Protection; Safety Evaluation including core and coolant boundary, standby safeguards analysis, and blowdown analysis; and operation including training and operational and administrative procedures. Included, also, are maps of the San Luis Obispo area, geological studies, and seismic evaluation of the site. Earthquake design criteria are given for the reactor containment systems and plant structures; oceanography and meteorology analyses for the site are included. (M.L.S.)

18371 (DOCKET-50277-1) PEACH BOTTOM ATOMIC POWER STATION, UNITS NO. 2 AND 3. Preliminary Safety Analysis Report, Vol. 1. (Philadelphia Electric Co., Pa.). Feb. 10, 1967. 450p. (DOCKET-50278-1). Dep. CFSTI.

Material is presented under the following titles: Introduction and Summary; Site and Environs; Reactor Design including fuel mechanical design, core nuclear characteristics, core thermal and hydraulic characteristics, and reactor vessel internal structure; Reactor Coolant System; Containment Systems; Engineered Safeguards; Radioactive Waste Control Systems; Plant Electrical Systems; Plant Control and Instrumentation; Reactor Auxiliary Services and Systems including fuel storage and fuel handling, reactor clean-up systems, reactor shutdown cooling system, reactor core isolation cooling system, and other service systems; Steam and Power Conversion Systems; Other Plant Structures; Conduct of Operations; Safety Analyses including incidents, design basis accidents (DBA), analytical methods, and excursion description. (M.L.S.)

18372 (DOCKET-50277-2) PEACH BOTTOM ATOMIC POWER STATION, UNITS NO. 2 AND 3. Preliminary Safety Analysis Report, Vol. 2. (Philadelphia Electric Co., Pa.). Feb. 10, 1967. 275p. (DOCKET-50278-2). Dep. CFSTI.

All drawings for Peach Bottom Power Station, Units 2 and 3, are presented in reduced size. In addition, a glossary of terminology and abbreviations used in the PSAR, a control rod drive system description and analysis, explanation of the use of jet pump circulation for the reactor coolant, the core spray test program, containment fission product retention capability, explanation of core thermal design, a comparative evaluation of the Peach Bottom plant with AEC design criteria, and an evaluation of the emergency core cooling systems are given. (M L.S.)

18373 (DOCKET-50277-5) PEACH BOTTOM ATOMIC POWER STATION, UNITS NO. 2 AND 3. [Preliminary Safety Analysis Report], Amendment 3. (Philadelphia Electric Co., Pa.). Sept. 26, 1967. 14p. (DOCKET-50278-5). Dep. CFSTI.

Additional information on: shutdown cooling in the event of loss of station cooling water, cooling towers, and water level resulting from Holtwood Dam failure is given. (M.L.S.)

18374 (DOCKET-50277-6) PEACH BOTTOM ATOMIC POWER STATION, UNITS NO. 2 AND 3. [Preliminary Safety Analysis Report], Amendment 5. (Philadelphia Electric Co., Pa.). Oct. 31, 1967. 6p. (DOCKET-50278-6). Dep. CFSTI.

The 1966 Annual Reports for the Philadelphia Electric Company, Public Service Electric and Gas Company, Delmarva Power and Light Company, and Atlantic City Electric Company are presented. These contain the financial statements and reports to stockholders of the owners for Peach Bottom Power Reactors, Units 2 and 3. (M.L.S.)

18375 (DOCKET-50280-1) SURRY NUCLEAR POWER PLANT SITE, VIRGINIA ELECTRIC AND POWER COMPANY: SEISMICITY ANALYSIS. [Preliminary Safety Analysis Report]. (Weston Geophysical Research, Inc., Mass.). Dec. 8, 1967. 33p. (DOCKET-50281-1). Dep. CFSTI.

For Stone and Webster Engineering Corp., Boston, Mass.

A seismicity analysis of the site for Surry Power Reactor, Units 1 and 2, is given. A general discussion of tectonics is given; the seismic history is reviewed. All seismicity data are shown in map form. 30 references. (M.L.S.)

18376 (DOCKET-50280-2) SURRY POWER STATION: TEST PILE PROGRAM. [Preliminary Safety Analysis Report]. (Stone and Webster Engineering Corp., Boston, Mass.). Dec. 8, 1967. 56p. (DOCKET-50281-2; NUS-1424). Dep. CFSTI.

For Virginia Electric and Power Co., Richmond.

The test pile program for the Surry Power Reactor, Units 1 and 2, site is described; findings are included. A description of subsurface conditions is given. Piling load tests are described. Specifications, pile driving records, load settlement readings, and computations are given. (M.L.S.)

18377 (DOCKET-50280-3) PROPOSED NUCLEAR POWER PLANT, SURRY, VIRGINIA: ENVIRONMENTAL STUDIES. Revised Report. [Preliminary Safety Analysis Report]. (Dames and Moore, New York). Dec. 8, 1967. 184p. (DOCKET-50281-3). Dep. CFSTI.

For Virginia Electric and Power Co., Richmond.

Environmental studies for Surry Power Reactor, Units 1 and 2 are presented. These include: Field Explorations including geologic, hydrologic, and seismologic characteristics; Laboratory Tests; Geology; and Hydrology. 23 references. (M.L.S.)

18378 (DOCKET-50280-4) SURRY POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 4, Suppl. Vol. 1. (Virginia Electric and Power Co., Richmond). Oct. 9, 1967. 225p. (DOCKET-50281-4). Dep. CFSTI.

Methods of detection of peaking factors and hot spots in-core for Surry Power Reactors, Units 1 and 2, are described. Procedures used in determining gap conductance between fuel pellet and cladding are discussed. Effects of peaking factors and hot spots are analyzed. Effects of operation of the safety injection systems near the end of the lifetimes of the Surry reactor vessels are considered. The use of activation detectors for radiation environment surveillance is described; analytical procedures for data are given. Effects of a loss-of-coolant accident on service water, containment spray, and safety injection systems are considered, briefly; an analysis of the thermal transient following a loss-of-coolant accident is given. Steam bubble formation in the pressure vessel head is evaluated. The design of the gaseous waste disposal system is described. A pressure analysis for a loss-of-coolant incident is presented in detail. Heat and energy transfer in the containment system are shown as a function of time. Various aspects of the containment spray system are considered. The report on the foundation dynamics for the Surry site is included. (M.L.S.)

18379 (DOCKET-50280-5) [SURRY POWER STATION, UNITS 1 AND 2]. [Preliminary Safety Analysis Report], Amendment 5. (Virginia Electric and Power Co., Richmond). Dec. 7, 1967. 98p. (DOCKET-50281-5). Dep. CFSTI.

Details of use of piezometers for water table determinations at the Surry Power Reactor site are given; locations of piezometers are shown. Data from exploratory borings to sample and classify the soils are tabulated; soil density data are given. The potential of earthquake-induced soil liquefaction at the Surry site is evaluated in detail. The computational methods used for calculation of safety factors against soil liquefaction are given. The earthquake amplification factors are described; calculations and calculational models for the amplification spectra are given. (M.L.S.)

18380 (DOCKET-50280-6) SURRY POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 7. (Virginia Electric and Power Co., Richmond). Jan. 4, 1968. 95p. (DOCKET-50281-6). Dep. CFSTI.

Use of external ion chambers in Surry Power Reactors, Units 1 and 2, is discussed. Effects of coolant loss accidents on system steam conversion components are considered. Effects of increase in containment vessel liner on containment pressure transients are analysed; energy absorbed in the various components of the containment system is shown as a function of time. Iodine dose in rem at site boundary is due to containment leakage during a reactor incident. (M.L.S.)

18381 (DOCKET-50280-7) SURRY POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 8. (Virginia Electric and Power Co., Richmond). Jan. 19, 1968. 17p. (DOCKET-50281-7). Dep. CFSTI.

Detailed calculations of structural movements caused by earthquakes are given. Ground motion is calculated as a function of distance between centroids of controlling areas; data are shown graphically. Dynamics tests on soils at the Surry Site are evaluated. (M.L.S.)

18382 (DOCKET-50280-8) SURRY POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment No. 6, Suppl. Vol. 2. (Virginia Electric and Power Co., Richmond). Dec. 15, 1967. 300p. (DOCKET-50281-8). Dep. CFSTI.

Answers to AEC questions are given. These cover the following: structural design excluding containment, containment isolation, containment structural design, instrumentation and control system, electrical power, analyses of in-core transients under various conditions, effects of turbine failure, consequences of turbine generator overspeed, fission product inventory in the cooling system, the model used for calculation of forces on pressure vessel internals, an analysis of effects of the emergency core cooling system, and environmental dose rate calculations for a hypothetical accident. (M.L.S.)

18383 (DOCKET-50280-9) SURRY POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Part B, Vol. 1. (Virginia Electric and Power Co., Richmond). Mar. 20, 1967. 300p. (DOCKET-50281-9). Dep. CFSTI.

Volume 1, Docket 50-280 and 50-281, of the Preliminary Safety Analysis Report for Surry Power Station, Units 1 and 2, contains: introduction and summary including introduction, summary, comparison with other stations, compliance with criteria, shared facilities and equipment, and conclusion; site description including general description, meteorology and climatology, hydrology, geology, and seismology; and reactor including general description, nuclear design-design bases, description, and analytical and evaluation methods, thermal and hydraulic design-design bases, description, and evaluation, mechanical design-design bases, description, evaluation, and tests and inspection. (M.L.S.)

18384 (DOCKET-50280-10) SURRY POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Part B, Vol. 2. (Virginia Electric and Power Co., Richmond). Mar. 20, 1967. 275p. (DOCKET-50281-10). Dep. CFSTI.

Volume 2, Docket 50-280 and 50-281, of the Preliminary Safety Analysis Report on the Surry Power Station contains the following: Reactor Coolant System; Containment System including containment structure, containment isolation, and the system, itself; Engineered Safeguards; Instrumentation and Control including protective systems, regulating systems, nuclear and non-nuclear process instrumentation; and Electrical Systems. (M.L.S.)

18385 (DOCKET-50280-11) SURRY POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Part B, Vol. 3. (Virginia Electric and Power Co., Richmond). Mar. 20, 1967. 250p. (DOCKET-50281-11). Dep. CFSTI.

Volume 3, Docket 50-280 and 50-281, of the Preliminary Safety Analysis Report for Surry Power Station contains: Emergency and Auxiliary Systems; Steam and Conversion Systems; Radioactive Wastes and Radiation Protection including liquid, solid, and gaseous disposal systems, tests and inspections, and shielding; Organization and Training; Initial Tests and Operation; and Safety Analyses including core and coolant boundary protection analysis, stand-by safeguards analysis, other incident analysis, and hypothetical incident analysis. (M.L.S.)

18386 (DOCKET-50280-12) [SURRY POWER STATION, UNITS 1 AND 2]. [Preliminary Safety Analysis Report], Amendment 1. (Virginia Electric and Power Co., Richmond). June 21, 1967. 70p. (DOCKET-50281-12). Dep. CFSTI.

Amendment 1, Docket 50-280 and 50-281, of the Preliminary Safety Analysis Report for Surry Power Reactor additional detailed analyses of the containment structure, electrical systems, component cooling systems, primary shielding, and hypothetical incident analyses are given. (M.L.S.)

18387 (DOCKET-50280-13) [SURRY POWER STATION, UNITS 1 AND 2]. [Preliminary Safety Analysis Report], Amendment 3. (Virginia Electric and Power Co., Richmond). Aug. 24, 1967. 40p. (DOCKET-50281-13). Dep. CFSTI.

Amendment 3, Docket 50-280 and 50-281, of the Preliminary Safety Analysis Report for Surry power Reactor contains answers to AEC questions on siting aspects related to hurricane and tornado protective measures, assurance of no radioactive buildup in the James River and protection of aquatic biota, and site relocation under seismic excitation. (M.L.S.)

18388 (DOCKET-50280-14) SURRY POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 9, Suppl. Vol. 3. (Virginia Electric and Power Co., Richmond). Feb. 14, 1968. 163p. (DOCKET-50281-14). Dep. CFSTI.

Efficiency of the containment spray systems for the Surry Power Reactors, Units 1 and 2, is evaluated in detail. Effects of hurricane produced surges in the James River are analyzed; consequences of river level depression due to blowout are considered; data are given. Physical effects on the containment structure and liner are discussed. An analysis of steam generator tube rupture is given; site boundary doses are determined. Variation of core coolant in the reactor vessel after piping ruptures is shown as a function of time. Effective reactor shutdown and safety measures, in the event of loss of access to the control room, are described. (M.L.S.)

18389 (DOCKET-50280-15) SURRY POWER STATION, UNITS 1 AND 2. [Preliminary Safety Analysis Report], Amendment 10. (Virginia Electric and Power Co., Richmond). Mar. 1, 1968. 34p. (DOCKET-50281-15). Dep. CFSTI.

Structural response spectra for long period earthquake motion effects on Surry Power Reactor, Units 1 and 2, are shown. Some supplementary information on the containment system is given. (M.L.S.)

18390 (DOCKET-50282-1) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, RED WING, MINNESOTA, UNITS 1 AND 2. Facility Description and Safety Analysis Report, Vol. 1. (Northern States Power Co., Minneapolis, Minn.). Aug. 30, 1967. 295p. (DOCKET-50306-1). Dep. CFSTI.

Information on Prairie Island Power Reactor, Units 1 and 2, is included under the following broad topics: Summary Description; Site and Environment; Reactor including nuclear design and evaluation, thermal and hydraulic design and evaluation, and mechanical design and evaluation; Reactor Coolant System; and Containment System which includes containment structure design, containment isolation systems, containment vessel air handling system, shield building vent system, leakage monitoring system, system design evaluation, and tests and inspections. (M.L.S.)

18391 (DOCKET-50282-2) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, RED WING, MINNESOTA, UNITS 1 AND 2. Facility Description and Safety Analysis Report, Vol. 2. (Northern States Power Co., Minneapolis, Minn.). Aug. 30, 1967. 280p. (DOCKET-50306-2). Dep. CFSTI.

Information on Prairie Island Power Reactor is included under the following broad topics: engineered safeguards including safety injection system, containment spray systems, containment vessel air handling systems; instrumentation and control including protective systems; control and regulation systems, nuclear instrumentation systems, nonnuclear process instrumentation, core instrumentation, operating control station, and control instrumentation; electrical systems; auxiliary and emergency systems; steam and power conversion system; radioactive wastes and radiation protection; conduct of operations; and safety analysis including core and coolant boundary protection analysis, standby safeguards analysis, and a blowdown analysis. (M.L.S.)

18392 (DOCKET-50282-3) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, RED WING, MINNESOTA, UNITS 1 AND 2. Facility Description and Safety Analysis Report, Vol. 3. (Northern States Power Co., Minneapolis, Minn.). Aug. 1967. 230p. (DOCKET-50306-3). Dep. CFSTI.

The meteorological and dose-calculation models used at Prairie Island Power Reactor, Units 1 and 2, are given; calculations are shown. Quantities of radioactive isotopes present in the core, fuel rod gap, coolant, volume control tank, and gas decay tank are tabulated. Probability of turbine generator overspeed is evaluated. The possibility of radiolytic decomposition of safety injection water is analyzed. A functional evaluation of the system components which are shared by the two reactor units is given. The possibilities of leakage of radioactive sources from the containment system are determined. The detailed Dames and Moore report on site geology, hydrology, and seismology is included. (M.L.S.)

18393 (DOCKET-50285-1) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 1, Suppl. 1, Exhibit F-1. (Omaha Public Power District, Nebr.). Aug. 3, 1967. 17p. Dep. CFSTI.

A comparison of Fort Calhoun, Unit 1 design parameters with Surry, Units 1 and 2, Turkey Point, Units 3 and 4, Oconee, Units 1 and 2, Palisades, Unit 1, and Robert E. Guina, Unit 1 is made; complete sets of design parameters are listed. Response spectra for maximum earth moving at the Fort Calhoun site are shown. (M.L.S.)

18394 (DOCKET-50285-8) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 8, Suppl. 8, Exhibit F-8. (Omaha Public Power District, Nebr.). Oct. 31, 1967. 237p. Dep. CFSTI.

Details on containment structure and containment construction are presented; effects of earthquakes are considered. The blowdown energy model is given; values of total energy absorption during blowdown are tabulated. Energy accumulated from metal-water reactions after termination of blowdown is tabulated. Results of double-ended 18" tube failure analyses are shown; break mass and break enthalpy are tabulated. Effects of safety injection and spray suppression systems on blowdown energy are shown graphically. Reactor vessel integrity is analyzed with respect to thermal shock effects induced by operation of the Emergency Core Cooling System. (M.L.S.)

18395 (DOCKET-50289-1) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Vol. 1. (Metropolitan Edison Co., Reading, Pa.). May 3, 1967. 220p. Dep. CFSTI.

Information on Three Mile Island Power Reactor, Unit 1, is given under the following broad topics: Introduction and Summary; Site and Environment; Reactor; Reactor Coolant System; Containment System; and Engineered Safeguards including the safety injection system, containment ventilation, and leakage and radiation considerations. (M.L.S.)

18396 (DOCKET-50289-2) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Vol. 2. (Metropolitan Edison Co., Reading, Pa.). May 3, 1967. 185p. Dep. CFSTI.

Information on Three Mile Island Power Reactor, Unit 1, is presented under the following broad topics: Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion System; Radioactive Waste and Radiation Protection; and Safety Analyses. (M.L.S.)

18397 (DOCKET-50289-3) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Vol. 3. (Metropolitan Edison Co., Reading, Pa.). May 3, 1967. 175p. Dep. CFSTI.

Information on Three Mile Island Power Reactor, Unit 1, is given under the following broad topics: Engineering Geology and Foundation Considerations, Seismology and Meteorology, Geology, Structural Design Bases, Design Program and Criteria for Reactor Building, Quality Control, Liner Plate Specifications, and Reactor Building Instrumentation. (M.L.S.)

18398 (DOCKET-50289-4) THREE MILE ISLAND NUCLEAR STATION, [UNIT 1]. Preliminary Safety Analysis Report, Amendment 4. (Metropolitan Edison Co., Reading, Pa.). Dec. 8, 1967. 100p. Dep. CFSTI.

Reactor Building penetrations and leakage are considered; station ventilating systems are described. Seismic design is evaluated. Schematics for area monitoring systems are given. Effects of turbine overspeed are considered. A dynamic analysis of the critical piping systems is given. The fluid block system for containment isolation is described in detail; schematics and tables summarize the information. The experimental testing program for the containment spray system is detailed; an analysis of the efficiency of such systems is given. (M.L.S.)

18399 (DOCKET-50289-5) THREE MILE ISLAND NUCLEAR STATION, [UNIT 1]. Preliminary Safety Analysis Report, Amendment 5. (Metropolitan Edison Co., Reading, Pa.). Dec. 22, 1967. 60p. Dep. CFSTI.

Effects of flood stages of the Susquehanna River on the Three Mile Island plant and plant feedwater are considered. Information on the guaranteed power supply is included; interaction of the guaranteed power supply with the engineered safety systems is evaluated. Effects of core barrel vibrations on valves are discussed; DNB ratios and flow characteristics after valve loss are given. Containment integrity is reviewed with respect to safety valve and steam generator tube leakage simultaneous to a coolant loss accident. Emergency Core Cooling System modifications are described. (M.L.S.)

18400 (DOCKET-50298-1) COOPER NUCLEAR STATION. [Preliminary Safety Analysis Report], Amendment 2. (Consumers Public Power District, Columbus, Nebr.). Jan. 25, 1968. 256p. Dep. CFSTI.

Sections of the original PSAR for Cooper Nuclear Station are identified with respect to applicability to the General Design Criteria. A description of the quality control procedures to be followed is given. A complete soil liquefaction analysis is given; seismic response of the soil profile is analysed. Detailed plans for controlling construction of structural fill are included. Supplementary analyses of the containment structure and its foundation are presented. Redesign of the Emergency Core Cooling System is described. Supplementary information on the instrumentation and control systems is given. The split-bus arrangement for the diesel generators is described. (M.L.S.)

18401 (DOCKET-50298-2) COOPER NUCLEAR STATION. [Preliminary Safety Analysis Report], Amendment 3. (Consumers Public Power District, Columbus, Nebr.). Feb. 10, 1968. 34p. Dep. CFSTI.

Compliance with the General Design Criteria is tabulated. Supplementary information on instrumentation and controls, standby AC electrical system, containment capability, reactor shutdown assuming access to main control room is limited, and stability of interconnecting high-voltage transmission lines. (M.L.S.)

18402 (DOCKET-50298-3) COOPER NUCLEAR STATION. [Preliminary Safety Analysis Report], Amendment 3, Part I.

(Consumers Public Power District, Columbus, Nebr.). Feb. 10, 1968. 6p. Dep. CFSTI.

The new design of the Emergency Core Cooling System for Cooper Power Reactor is described; some parameters are given. (M.L.S.)

18403 (DOCKET-50298-4) COOPER NUCLEAR STATION. [Preliminary Safety Analysis Report], Amendment 4. (Consumers Public Power District, Columbus, Nebr.). Feb. 10, 1968. 10p. Dep. CFSTI.

The logic for the Low Power Coolant Injection (LPCI) system is described; rationale for omission of the equalizer line is given. An operational control analysis for the LPCI system is included; network response is shown as a function of time. (M.L.S.)

18404 (DOCKET-50298-5) COOPER NUCLEAR STATION. [Preliminary Safety Analysis Report], Amendment 5. (Consumers Public Power District, Columbus, Nebr.). Feb. 20, 1968. 13p. Dep. CFSTI.

The selection of heat exchangers for the residual heat removal system is discussed; the efficiency of these in providing containment capability is evaluated. Effects of the core spray system, in conjunction with the residual-heat-removal heat exchangers, are considered; data are shown graphically. (M.L.S.)

18405 (DOCKET-50298-6) COOPER NUCLEAR STATION. [Preliminary Safety Analysis Report], Amendment 5, Part I and II. (Consumers Public Power District, Columbus, Nebr.). Feb. 20, 1968. 3p. Dep. CFSTI.

Tornado and wind loading design criteria for the Class I structures for the Cooper Power Reactor site are described. (M.L.S.)

18406 (DOCKET-50300-1) EASTON NUCLEAR STATION. Preliminary Safety Analysis Report, Amendment 1, Suppl. 1, Exhibit B-1. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Mar. 1, 1968. 133p. Dep. CFSTI.

A comparison of the design of the Easton Power Reactor and the proposed General Design Criteria is outlined. A discussion on the research and development of engineered safeguards is given; quality control programs for containment system components are delineated; in-service inspection procedures are tabulated. Possible effects of the Hudson River on the Easton Site are evaluated. Dose rates from stack effluent because of postulated accidents are tabulated; results are shown graphically. Foundation for the containment vessel is described; results of subsurface explorations are given. Effects of external loadings, such as wind and earthquake are considered. Thermal shock on reactor components induced by Emergency Core Cooling System (ECCS) operation is evaluated in detail. Methods of stress analyses for the containment system are given; penetration leak test capability is discussed. The design of the Emergency Core Cooling System is described; the design basis for the torus-shaped suppression chamber is given. Discussions of electrical supply to emergency systems, control systems and instrumentation are given. The mode of operation for the Low Pressure Coolant Inspection (LPCI) system is detailed; circuit logic is described. (M.L.S.)

18407 (DOCKET-50301-1) POINT BEACH NUCLEAR PLANT, UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Suppl. 1. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Jan. 22, 1968. 252p. Dep. CFSTI.

Redesign of Emergency Core Cooling System is discussed. Additional information on containment integrity during post loss-of-coolant accident energy release is given; effects of energy release from $Zr-H_2O$ reactions are considered. External electric supply to emergency systems is described; the guaranteed power system is detailed. In-core coolant volume and pressure are shown as a function of time for rupture of various size pipes. Detailed information on a postulated steam-line-break accident is given. A transient analysis of sudden failure of a coolant pump is presented. Emergency procedures are detailed. Direct radiation doses and fission product inhalation exposures are given for control room access from outside the plant after a design-basis accident. (M.L.S.)

18408 (DOCKET-50309-1) [MAINE YANKEE NUCLEAR POWER PLANT]. [Preliminary Safety Analysis Report], Amendment 1. (Maine Yankee Atomic Power Co., Augusta). Jan. 15, 1968. 21p. Dep. CFSTI.

Material consisting of revised pages of the original PSAR is included under core characteristics, steam generator parameters, and safety systems and analyses. (M.L.S.)

18409 (DOCKET-50309-2) MAINE YANKEE NUCLEAR POWER PLANT, BAILEY POINT, WISCASSET, MAINE: SEISMICITY ANALYSIS. [Preliminary Safety Analysis Report], Amendment 3. (Weston Geophysical Research, Inc., Mass.). Feb. 5, 1968. 72p. Dep. CFSTI.

For Maine Yankee Atomic Power Co., Augusta.

The general geology, tectonics, and seismicity of the site for the Maine Yankee Power Reactor is described. Maps of tectonics, earthquake intensity VI or greater and intensity attenuation scales are given. 81 references. (M.L.S.)

18410 (DOCKET-50309-3) MAINE YANKEE ATOMIC POWER PROJECT, BAILEY POINT, WISCASSET, MAINE: GEOLOGICAL CONSIDERATIONS. [Preliminary Safety Analysis Report], Amendment 4. Rand, John R. (Stone and Webster Engineering Corp., Boston, Mass.). Feb. 5, 1968. 47p. Dep. CFSTI.

For Maine Yankee Atomic Power Co., Augusta.

A geological analysis of the site for the Maine Yankee Power Reactor is given. Analyses of both bedrock and surficial layers are made. Diamond drill hole logs are included. (M.L.S.)

18411 (DOCKET-50309-4) [MAINE YANKEE NUCLEAR POWER PLANT]. [Preliminary Safety Analysis Report], Amendment 2. (Maine Yankee Atomic Power Co., Augusta). Jan. 15, 1968. 12p. Dep. CFSTI.

Revisions of the original PSAR for Maine Yankee Power Reactor concerning the environmental surveillance program, the engineered safeguards flow diagram, and the chemical and volume control diagram are included. (M.L.S.)

18412 (DOCKET-50313-1) RUSSELLVILLE NUCLEAR UNIT. Preliminary Safety Analysis Report, Suppl. 1. (Arkansas Power and Light Co., Little Rock). Jan. 24, 1968. 31p. Dep. CFSTI.

Information pertaining to the applicability of the Russellville Power Plant design to the proposed 70 General Design Criteria is included. (M.L.S.)

18413 (DOCKET-50317-1) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. [Preliminary Safety Analysis Report]. (Baltimore Gas Electric Co., Md.). Jan. 25, 1968. 33p. (DOCKET-50318-1). Dep. CFSTI.

The application for license for Calvert Cliffs Power Reactor, Units 1 and 2, contains the general information as required by 10 CFR 50.33. (M.L.S.)

18414 (DOCKET-50317-2) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 1. (Baltimore Gas Electric Co., Md.). Jan. 25, 1968. 462p. (DOCKET-50318-2). Dep. CFSTI.

Information on Calvert Cliffs Power Reactor, Units 1 and 2, is given under the following broad headings: Introduction and Summary; Site and Environment including general description, population and land use, meteorology, geology, hydrology, seismology, surface and foundations, Chesapeake Bay studies, and environmental radioactivity; Reactor; Reactor Coolant System; Containment System; Engineered Safeguards including safety injection systems, containment spray system, containment emergency cooling system, and containment ventilation; Instrumentation and Control; Electrical Systems; Auxiliary Systems; and Steam and Power Conversion Systems. (M.L.S.)

18415 (DOCKET-50317-3) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 2. (Baltimore Gas Electric Co., Md.). Jan. 25, 1968. 552p. (DOCKET-50318-3). Dep. CFSTI.

Information on Calvert Cliffs Power Reactor, Units 1 and 2, is given under the following broad topics: Waste Processing and Radiation Protection; Conduct of Operations; Initial Tests and Operation; Safety Analysis including control element assembly withdrawal incidents, boron dilution incident, dropped control element assembly incident, loss of coolant incident, and blowdown. Included in appendices are: Qualifications of Contractors; Proposed AEC General Design Criteria; Meteorology, Geology, Hydrology, and Seismology information and data from contractor firms; Subsurface and Foundation and Hurricane Tidal Effect studies performed by consultants; Design Bases; Containment Proof Tests; Rebar Splicing; Load Factors; Yield Factors; Finite Element Method for containment structural analysis; Field Welding of Liner Plate; Containment Structure; Liner Plate Stability; and Turbine Missiles. (M.L.S.)

18416 (EUR-3657) PROGRAMME OF RESEARCH ON THE TRINO VERCELLESE NUCLEAR POWER PLANT FOR THE DEVELOPMENT OF CLOSED-CYCLE WATER REACTOR TECHNOLOGY. Annual Report, June 1, 1966–June 30, 1967. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Sept. 22, 1967. Contract 071-66-6 TEEI. 81p. Dep.

In the reactivity balances program a two-group zero-dimensional model was studied. The influence of the control rods and xenon on the temperature coefficient was investigated. For the control rods, the simplified super-cell theory was used. The burnup was also theoretically evaluated. A pH variation test was carried out to obtain effects on the reactivity of the core. The neutron flux background was measured to order to determine variations in the surface boiling of the core due to pH variation. Surface boiling tests were performed by varying the mean temperature of the coolant in order to change the degree of boiling in the core while at constant power. The power was then varied at constant mean temperature. In both cases the control rod position remained unchanged. In-core measurements (Aeroball system) made during the first cycle operation were analyzed to give the time curve of the axial and radial form factors and show how they are influenced by the core parameters such as control rod insertion, burnup, xenon distribution, mean coolant temperature, and power level. (auth)

18417 (EURAEC-1956) BEHAVIOR OF GARIGLIANO REACTOR CORE IN SIMULATED CYCLE AT INCREASED POWER. Special Report No. 4. Bannella, Roberto (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Nov. 1966. Contract 101-63-11-RDI. 38p. (EUR-3766). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The possibility is investigated that the Garigliano core can be operated at more than rated power without exceeding the limits of the initial design as to maximum heat fluxes across fuel cladding and the minimum burnout ratio. Core behavior at 620 MW(t) was investigated by simulating a complete fuel cycle on the power plant computer. Rated capacity of the core is 506 MW(t). It is concluded that the core can operate satisfactorily at 620 MW(t) by appropriate planning of the control rod withdrawal sequence. (H.D.R.)

18418 (EURAEC-1985) GARIGLIANO NUCLEAR POWER STATION RESEARCH PROGRAM. Final Report. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Dec. 1, 1967. Contract 101-63-11-RD-I. 56p. (EUR-3783). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

GARIGLIANO POWER REACTOR—pressure vessel for, irradiation testing of specimen materials for; fuel assemblies for, fabrication and installation of instrumented
PRESSURE VESSELS—irradiation testing of specimen materials in Garigliano Power Reactor for, description of
NICKEL STEEL, CHROMIUM STEEL, MOLYBDENUM STEEL—Cr–Mo–Ni, mechanical properties of, radiation effects in Garigliano Power Reactor on
REACTOR FUEL ELEMENTS—assemblies for Garigliano Power Reactor, description of instrumented
REACTOR SAFETY—stability testing of Garigliano Power Reactor, analysis of
REACTOR CONTROL SYSTEMS—operation of Garigliano Power Reactor, testing for stability in
GARIGLIANO POWER REACTOR—stability of, testing for

18419 (FOA-2-2498-44) ANALYS AV MEKANISK SKADEVERKAN VID EN NUKLEAER EXKURSION. (Analysis of Mechanical Damages at Nuclear Excursions). Askloef, C. A.; Persson, A. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Sept. 1967. 27p. (In Swedish). Dep.

An analysis is made of the mechanical damages by a nuclear excursion in a fast steam-cooled reactor. The probability of penetration of the reactor tank by fragments is judged to be low. The radial expansion direction of the reactor core resists twice as much released energy as the axial direction. The damages in the axial direction depend on the release of kinetic energy and are estimated to be: Less than 800 MJ—no deformation of the reactor tank; 800–1700 MJ—local penetrations in bottom and cover, ejections may occur; 1700–3000 MJ—great hazard of ejections at speeds of 60 m per sec; more than 3000 MJ—bottom and tank may be demolished and the tank moved. (Swed)

18420 (NUS-428) REACTOR OPERATION'S SAFETY ANALYSIS MONTHLY REPORT NO. 29, NOVEMBER 1–DECEMBER 31, 1967. (NUS Corp., Washington, D. C.). Contract AT(11-1)-651; Subcontracts No. 4, 5, and 9. 167p. Dep. CFSTI.

For Rural Cooperative Power Association, Elk River, Minn.

The reactor plant operated continuously during November and December. Secondary water activity and turbine air ejector (TAE) activity levels remained consistent with previously reported data. All levels were well below the alarm points. Variations in the TAE effluent activity levels resulted from off-gas operation and power level changes. Plant radiation levels have generally remained unchanged except for readings in the shield cooling system and startup heater monitors attributed to crud accumulation at the inlet valve to the purification system. Radiation levels at the subcoolers would indicate possible minor tube leakage in the number 2 evaporator. The primary makeup water rate has increased to approximately 50 gallons per day. Analyses of water collected from the lower reactor cavity drain and air particulate samples of the cavity vent indicate that the source of leakage into the cavity is not primary coolant. The true source is not known, but the fuel element storage well is suspect. Primary coolant iodine levels and ^{131}I concentrations showed considerable variation during the period with a slight but definite upward trend. It appears that fuel element defects are present. Calculation of a source term based on the observed coolant iodine concentrations indicates a release of fission products from about 0.22 grams of ^{235}U. The coolant pH during the period measured approximately 6.5% at the purification outlet. Conductivity was generally below 0.5 μmhos except for a transient spike resulting from a change in the on-stream demineralizer. An increase in soluble ^{64}Cu to approximately 1.2×10^{-3} μCi/ml is most likely due to continued operation of the off-gas system and the resultant dissolved oxygen present in the primary system. The decay heat system instrumentation has been reviewed in light of the temporary pump operation during the refueling shutdown to confirm instrumentation adequacy for temporary pump operation and permanent pump operation at primary system pressure. Minor modifications of the decay heat system instrumentation are presented to improve control over the decay heat pump operation and measurement of pump performance data. Revised procedures are presented governing the Class B leak testing of the personnel and emergency air locks. A summary of the Fuel Element Bowing and Clad Defect task is presented. Through examination following shutdown, bowing was observed in 67 out of 166 fuel assemblies. The presence of clad defects in 22 other assemblies was determined by the dry sipping operation. The history of manufacture and operation of ERR fuel and the status of the fuel in terms of presence of bowing or defects are treated. In addition, areas of concern for future operation are investigated including mechanism of bowing, an estimation method for the prediction of future defects, and operational considerations with bowed and defected rods based on critical heat flux limits and plant activity release. The desirability and the nature of hot cell inspection for further examinations of the fuel elements are also discussed. (auth)

18421 (ORNL-TM-1638(Pt.28)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 28. TEMPERATURE SERVO DEMAND DRIVE UNIT, ORNL MODEL Q-2628. Fray, E. N. (Oak Ridge National Lab., Tenn.). Jan. 22, 1968. Contract W-7405-eng-26. 13p. Dep. CFSTI.

The Temperature Servo Demand Drive Unit provides a means of changing the setpoint, at a fixed rate, of a nuclear reactor rod controller or servo. The module basically consists of a motor-driven potentiometer with adjustable limit switches. The module is intended for use in the Molten-Salt Reactor Experiment temperature servo, and is packaged in a standard 2-unit plug-in module of the ORNL Modular Reactor Instrumentation series. The circuit, application, maintenance procedures, and acceptance tests for the unit are described. (auth)

18422 (PRWRA-119) REACTOR OPERATIONS AT THE BONUS PLANT. Monthly Report No. 10. (Puerto Rico Water Resources Authority, San Juan). Oct. 1967. Contract AT-(40-1)-2672. 15p. (WRA-B-67-20). Dep. CFSTI.

The investigation to determine the cause of the reduction in reactor recirculation flow is described. An inspection of the BONUS core was made. Ten (10) boiler fuel assemblies were transferred from the reactor to the fuel storage pool. Crud layers were observed in the boiler orifices. The area below the core plate was generally clean and no deflection of the poison injection distributor pipe or its supporting fins was observed. Six (6) of the boiler fuel assemblies transferred to the fuel storage pool were inspected with the use of TV camera and a video tape was recorded for each exposure. All of those inspected showed an accumulation of dust like particles in the lower end fitting holes. When the fuel assemblies were probed at the end fitting a dust cloud was produced. Control rod #3, from core position 8 was also inspected with the TV camera. A piece of the tip of this control rod had fallen off during a recent control rod inspection. The inspection of the control rod actuator graphitar bushings was completed and all bushings were replaced. Preparations for the next containment building leak test were started. (auth)

18423 (STI/PUB-154) CONTAINMENT AND SITING OF NUCLEAR POWER PLANTS. Proceedings Series. Proceedings of a Symposium held in Vienna, 3–7 April 1967. (International Atomic Energy Agency, Vienna (Austria)). 1967. 818p. (CONF-670402). IAEA: $16.50; S 427,-; £5.16.6; F Fr 80,90; DM 66,-.

Forty eight papers are presented on the siting and containment of nuclear power plants; the scope is international. Separate abstracts are prepared for forty five of the papers. (M.L.S.)

For abstracts of individual papers see: 18425–18467, 18561, and 18562.

18424 (TID-24282) ARDENNES NUCLEAR POWER PLANT QUARTERLY REPORT NO. 21, JULY 1–SEPTEMBER 30, 1967. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-Lez-Givet (France)). 24p. Dep. CFSTI.

Topics discussed include: operation schedule during the quarter; a review of incidents in performance; description of testing program; and an itemized fuel stockpile. (D.C.C.)

18425 NUCLEAR PLANT SITING IN THE UNITED STATES OF AMERICA. Davis, W. K.; Robb, J. E. (Bechtel Corp., San Francisco). pp 3-18 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Basic factors in nuclear plant siting, including availability of sufficient quantities of cooling water, site accessibility, presence of adequate soil bearing capacity, foundations, population distribution and flooding, are reviewed. Tabulations comparing these factors for the more recent sites in the United States are presented. Seismology and tornado design features are compared and discussed. The inter-relation between topography, meteorology and disposal of radiative gases from normal operation is discussed. The site accessibility discussion includes the desirability of railroad access to the site with penalties for lack of rail access evaluated. Construction access requirements including transportation of the reactor pressure vessel and turbine-generator components are considered. A discussion is included on the public acceptance considerations in nuclear plant siting. Recent trends, pertinent to very large nuclear stations, are noted and the relative importance of each factor is evaluated. (auth)

18426 APPLICATION OF "A GUIDE TO REACTOR SITE EVALUATION" IN JAPAN. Osawa, H.; (Science and Technology Agency, Tokyo); Togo, Y. pp 19–33 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The Japan Atomic Energy Commission (JAEC) has issued "A Guide to Reactor Site Evaluation" to give a provisional criterion for site selection. The basic idea of the guide is that even if a certain postulated accident occurred which released fission products, the public in the surrounding area should not suffer from radiation hazards. "Major accident" and "hypothetical accident" are defined as postulated accidents; the former is connected with a non-residential area and the latter with a low-population area and population center distance. In a safety analysis such as this, the method of evaluation of meteorological conditions is as important as the assumption of an accident. Therefore the JAEC has issued "Meteorological Guidance for Reactor Safety Analysis." Construction permits for three commercial power reactors have recently been granted after JAEC examined the safety of the reactors according to the two JAEC documents mentioned above. The data, derived from many conservative premises, seem to show that site selection for a light-water reactor is not a problematic matter in Japan as long as it concerns the safety estimated by accident analysis. On the other hand, however, waste disposal and its treatment may be a problem affecting the site selection of a reactor. The proximity of reactors to population centers seems to present a problem, owing to the fear of the Japanese of radiation hazards. (auth)

18427 PROBLEMS IN SITING NUCLEAR POWER PLANTS IN JAPAN AND EFFORTS TO SOLVE THEM. Inouye, T. (Ministry of International Trade and Industry, Tokyo). pp 35-48 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The rapidly growing demand for energy in Japan will require a total capacity of 30 to 40 thousand MWe in nuclear power by 1985. Materialization of this development programme must naturally be supported by securing the requisite sites for the nuclear power plants. The following factors make siting of nuclear power plants more difficult in Japan than in any other country: a small, densely populated territory with little level land, that is already completely utilized for agricultural and/or industrial purposes: small rivers and an active marine-product industry developed along most of the seacoast, both of which create difficult cooling-water problems; frequent earthquakes; and the fear of possible radioactivity, which prevails in the only nation in the world to have suffered from the atomic bomb. Quantative analysis of reactor siting factors and suggested measures for solving the siting problem are discussed. The analyses are based on nuclear power plant sites assumed to be located on the seacoast and characterized by low-population density desirable geology and favourable topography. It was assumed that seacoast siting is more economical than inland siting. It is shown that approximately 10% of the total coastline areas would be eligible for reactor siting, but most of these areas in this case are located in the northern part of Japan, far from load centers. Unfortunately, less than 1% of the total coastline has areas eligible in the central part of Japan where the electric power demand is large. The results suggest that developments of earthquake engineering, as well as of engineered safeguards, which would enable nuclear power plant construction to cope with the actual situations in Japan, should be carried out as the most important measures for securing sites near the load centers. (auth)

18428 SITE EVALUATION AND DIFFUSION CALCULATION PROCEDURES IN THE UNITED STATES OF AMERICA. Morris, P. A.; Waterfield, R. L. (Atomic Energy Commission, Washington, D. C.). pp 49-63 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Reactor siting in the United States is controlled through a licensing procedure carried out by the United States Atomic Energy Commission. Suitability of a site is based on the calculated dose to individuals at the site boundary for the first two hours after an assumed accident and the dose at the edge of the low-population zone during the course of the accident. The input for this calculation evolves from a comprehensive review of the characteristics of the site, the reactor, its containment, and its engineered safeguards. Siting factors which should be considered are enumerated in the Commission's Reactor Site Criteria: the relation of these factors to the design of the reactor and its engineered safeguards is discussed. In site evaluation one finds that systems which produce a delay in fission-product release are most effective during the first two hours, while those which have a cumulative effect, such as pressure reduction and recirculating containment atmosphere cleanup, are the most effective for the duration of the accident. Equations for evaluating these reductions are given and restrictions on their use are discussed. Methods are described for reducing the value of the inventory of various classes of fission products in the core to a single decay curve expressed directly in dose units. Values from these curves can be readily converted to off-site doses to individuals through the use of standard graphs of atmospheric diffusion, plus reduction factors due to the engineered safeguards. Dose ratios with and without various systems are given in a parameter study to show that the reliability and redundancy of a system must increase as its dose reduction factor increases. A tabulation of data is given for a number of approved reactor sites and facilities in the United States. (auth)

18429 CONTAINMENT AND SITING REQUIREMENTS IN CANADA. Boyd, F. C. (Atomic Energy Control Board, Ottawa). pp 67-75 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The present early stage of development of large nuclear power reactors has led to a requirement in Canada for siting restrictions and "containment" provisions. The latter, in conjunction with reliable operating and protective equipment, are intended to reduce to an acceptable level the probability of a serious release of fission products to the public. In considering the suitability of a site and the adequacy of the containment provisions, the Atomic Energy Control Board, which is the regulating agency, has developed siting criteria which consider: normal releases of radioactive material from the plant, the size of potential accidental releases, the probability of accidents, and the density of the surrounding population. Design guide values are given for the radiation exposure both of individuals and the total population at risk for three conditions: normal operation, failures of operating or "process" equipment only, combined failures of process and protective equipment. From the application of known or stated meteorological conditions an "acceptable" release from the plant can be determined. When combined with predicted releases from reactor for various accidents within the last two categories above this will give the total "allowable" fractional release from the containment. The exposure limits for normal operation follow the recommendations of the ICRP. Siting criteria application to

Pickering Generating Station and the Gentilly Station is discussed. 17 references. (auth)

18430 SITE OF THE FIRST SPANISH NUCLEAR POWER STATIONS. Pascual, F.; Alonso, A.; Norena, S.; Sevilla, A. (Junta de Energia Nuclear, Madrid). pp 93-105 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In Spanish).

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Sites of three Spanish nuclear power stations: the Zorita station with a pressurized water reactor and single containment; the Santa Maria de Garona station with a boiling water reactor and containment by steam condensation; and the Vandellós station with a graphite-moderated gas-cooled reactor and integrated design of the EDF-4 type are described. The normal criteria and the safety considerations governing the choice of site is discussed; the influence of Spanish orography on the transport of heavy equipment and hence its repercussions on the selection of power station sites is evaluated. Reference is made to the experience acquired in transporting equipment for the Zorita plant, and an analysis of the practical difficulties encountered in applying particular safety standards to the sites of stations of different types and designs is included. Since the type of reactor and its containment system affect the practical value of applying particular standards, these safety standards for assessing power station sites should be appropriate and flexible. The geological and meteorological features of the three Spanish sites are summarized; studies carried out in these fields are described. The hydrological studies carried out at Zorita and Santa Maria de Garona are discussed; the weather stations set up at both sites, the diffusion experiments with neutral-buoyancy balloons at Santa Maria de Garona, and the results of these investigations are described. 10 references. (auth)

18431 CRITERIA APPLIED IN THE RECENT CHOICE OF SITE FOR THE FIRST ARGENTINE NUCLEAR POWER STATION. Evans Morgan, E.; Somaruga, J. B. (Comision Nacional de Energia Atomica, Buenos Aires). pp 107-18 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In Spanish).

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The criteria applied in the choice of site for the first Argentine power reactor fall under two main headings: station construction, and station operation. The first heading covers, in addition to proper integration of the station into the grid, the availability of cooling water, favorable topography, suitable foundations, easy access, and acceptable hydrological, soil and meteorological conditions. The second heading covers, apart from measures relating to the prevention of reactor accidents and the containment of the radioactivity, such items as the features of the site in relation to centers of population, assuming that the safety measures cannot entirely prevent an escape of fission products. (auth)

18432 CRITERIA FOR SITING NUCLEAR POWER PLANTS. Crancher, D. W. (Australian Atomic Energy Commission, Sydney). pp 119-25 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

There have been some successful recent moves towards international uniformity in legislation for nuclear liability. However, there has been less success in obtaining uniform standards in the related field of reactor siting criteria and safety. Different approaches to safety and siting have evolved separately in the large industrial countries which have nuclear energy programmes. Many more nations, including developing nations, will have nuclear power programmes within the next decade and some uniformity in safety standards and siting criteria is highly desirable. There are two broad categories of national siting criteria: in one, sites are chosen on the basis of limiting reference doses used in conjunction with a maximum credible accident and in the other, sites are classified according to density of population. A suitable basis for uniformity can be found in criteria based on reference doses to the whole-body thyroid and possibly total population. There is general agreement on the use of a whole-body reference dose of 25 rem which represents a fourth-order risk. This value also agrees with recommended action level doses. Thyroid reference doses up to 300 rem to adults are used. In this environment children would be exposed to a second-order risk of developing thyroid carcinoma. It is suggested that the thyroid reference dose should represent a risk to the individual equivalent to that of the whole-body reference dose and should as far as possible be consistent with recommended action level doses. On this basis the thyroid reference dose should not exceed 50 rem to an infant. It is suggested that an accident based on the coincidental unrelated failure of not less than two systems be used in conjunction with the reference doses for assessing sites. 11 references. (auth)

18433 SAFETY AND SITING OF NUCLEAR POWER STATIONS IN THE UNITED KINGDOM. Adams, C. A.; Stone, C. N. (Central Electricity Generating Board, London). pp 129-42 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

A policy of remote siting for nuclear power stations in the United Kingdom conflicts with the preservation of places of natural beauty and with recreational or scientific interest. There is also a financial penalty associated with usage of sites which would not be first choices on technical grounds. An expanding nuclear power programme will increase both penalties at an accelerating rate if the siting criteria remain unaltered. It is therefore desirable to examine what compensating advantages are given by the current siting policy and to attempt to develop criteria which are not unnecessarily restrictive. Some easement of the problem would in any case be expected because of improved design, better methods of safety assessment and operating experience. A comprehensive review must however start from a consideration of accident consequences. The minimum requirement must be that the risk, for any individual, of becoming a casualty through the inhalation of airborne radioactivity resulting from an accident should be below some agreed level. Within a low-population zone near the station the requirement might be met by showing that remedial measures such as iodide administration or evacuation could reduce the risk below the agreed level. Outside this zone the only requirement would be that the safety assessment should have shown that the specified risk is not exceeded. No limitation on population numbers would be necessary beyond that possibly required to make emergency measures practicable in the low population zone. If the safety assessment gives probabilities of releases of various magnitudes the other accident consequences such as whole-body radiation doses, food contamination and various sociological effects could also be associated with probabilities and expressed in terms of expected frequency of occurrence. It is suggested that in considering whether these consequences require further limitation on the accident potential of reactors it is no longer appropriate to consider psychological effects and that the relevant factors are only those leading to interruption of normal life from physical causes. 10 references. (auth)

18434 A SUMMARY OF EXPERIENCE IN THE PRACTICAL APPLICATION OF SITING POLICY IN THE UNITED KINGDOM. Charlesworth, F. R.; Gronow, W. S. (Inspectorate of Nuclear Installations, London). pp 143-70 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

A method of evaluating sites in terms of the hazard to the public is presented; recommendations with regard to the safeguarding measures which should be taken to protect the close-in population are given. The evaluation also takes into account the general distribution of population as well as that part resident in the most densely populated sector. Some observations on the accident probability concept in reactor safety are described, recognizing that it is a useful tool in the evolution of reactor safety and may eventually provide a more rational basis for safety assessment. 10 references. (auth)

18435 ANALYSIS OF CRITERIA AND THEIR APPLICATION IN SITE SELECTION FOR NUCLEAR POWER PLANTS IN YUGOSLAVIA. Carlbom, L. (Aktiebolaget Atomenergi, Studsvik, Sweden); Obradovic, J.; Mojovic, L. pp 171-81 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Most of the criteria referring to site selection are common to both conventional thermal power plants and nuclear power plants, although the criteria are not of equal importance and influence in both cases. The new factors to be taken into account in the choice of the site for a nuclear power plant are radioactive hazard and contamination of the surroundings. The importance of particular criteria could be expressed with economic figures. The economic figures should also comprise the necessary adjustment of plant design to suit the site conditions. Criteria influencing site selection are discussed. Due attention is devoted to power demands, hydrology, seismology, radioactive hazard, population, meteorology, geology, hydrogeology, transport and communications. An attempt to provide the basis for zoning of the territory of Yugoslavia through qualitative analysis of particular criteria is described. The country is divided into regions differing in the degree of their suitability for building of nuclear power plants, beginning from very suitable areas to those which are to be excluded owing to their explicit inconvenience. On the basis of such zoning, a certain number of macro-sites for comparative analysis has been chosen. The economic aspects of the criteria concerned are given. The majority of the above-stated criteria can be expressed through the difference in investment and operating costs. The methods used to assess the cost figures for individual criteria are described. It appears difficult to express some of the criteria by a cost figure in a satisfactory way, a typical one being the influence of the degree of seismology on the operation of the plant. (auth)

18436 QUANTITATIVE EVALUATION OF NUCLEAR POWER STATION SITING FROM THE POINT OF VIEW OF SAFETY. Serment Cabrero, V. (Comision Nacional de Energia Nuclear, [Mexico City]. Univ. Nacional Autonoma de Mexico, [Mexico City]); Velez, C. pp 183-90 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In Spanish).

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Apart from the minimum operational and safety requirements for the siting of nuclear power stations, use of the total mean dose to the general population as an additional criterion is proposed. Although the calculation of this dose presupposes a detailed knowledge of the main pathways by which the population may be irradiated in case of an accident, the present state of power reactor technology makes it possible to tackle the problem already. An estimate of the total mean dose per unit time involves the safety aspects of the reactor, the features of the site considered, and the way in which these features affect safety. The general formula expressing the total mean dose as a function of all the parameters concerned is developed. In the case of accidents in which the release of fission products is independent of the mechanisms of irradiation, this formula is considerably simplified; it is then possible to establish a classification of the relative suitability, from the safety point of view, of the sites proposed without touching upon the difficult problem of the definition of accidents and their probabilities of occurrence. A further simplification accrues when predominant mechanisms governing the accidental irradiation of the population exist. The approach adopted is particularly well suited to calculations with digital computers, and helps to identify the areas in which information is lacking and to direct research intended to remove these deficiencies. 10 references. (auth)

18437 SELECTION AND ASSESSMENT OF POSSIBLE SITES FOR A NUCLEAR POWER STATION TO PROVIDE ELECTRICITY FOR THE MEXICAN GRID. Sucar Sucar, F. (Comision Nacional de Energia Nuclear, Mexico City). pp 191-202 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In Spanish).

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Power demands and availability in Mexico are discussed. Problems in siting of nuclear power plants in the most advantageous areas are described; factors which must be considered are evaluated. (M.L.S.)

18438 CONCEPT OF A STANDARD SITE. Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 205-18 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Containment limits the release of radioactive material from a reactor to the atmosphere. Correct siting increases the probability that the material will be well diluted before it reaches centers of population. Adequate provisions can be specified if the maximum acceptable consequences are defined and the rate of dispersal is known. It is shown that, with a few minor exceptions, the differences between the atmospheric dispersion rates at different power reactor sites are, for the practical purpose, insignificant. A standard site is therefore proposed (which, in concept, is comparable to that of standard man). The problem of providing a degree of containment suited to a particular site has always been difficult, mainly because the differences, like those between individual men, appear more important than they really are. The emphasis on details obscures the essential similarities. The definition of the standard site includes a new approach to the problem of estimating atmospheric dispersion rates. The usual approach is dominated by the concept of the minimum rate of dispersion in adverse weather of a maximum credible release of radioactive material. The new approach estimates not a minimum dispersion rate but the probability that any given rate will occur. With the information in this form a properly calculated risk can be taken when the required degree of containment is specified. The results of a direct experimental determination of the required probabilities are given. 25 references. (auth)

18439 CORRELATION BETWEEN REACTOR SITING AND CONTAINMENT. Knecht, O. (Interatom, Bensberg, Ger.). pp 219-26 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The expectation value of damage (risk) and a general safety factor κ_0 of a plant is defined. Applying this factor to nuclear reactor plants we can define a partial safety factor κ_1, which can be understood as a typical number of the plant with respect to potential hazard to the surroundings. For a given plant the value of κ_1 is a function of the population density and other typical factors of the reactor site; however, κ_1 is also dependent on the effectiveness of the containment. If we consider this problem from the point of view of economics it can be shown easily that costs of a containment should not exceed the expectation value of damage in the surroundings if there is not containment. Unfortunately, this value cannot be calculated precisely enough because both the probability and the damage (consequence) cannot be determined precisely. In addition the question of equivalent worth of human health and life arises, which is difficult to answer. However, if we also take into consideration the simultaneous damage caused inside the plant by the above-mentioned nuclear accidents, we can conclude that safety measures for reduction of the probability of accidents seem to be more economic. Therefore in the future more emphasis should be put on the question of how to avoid accidents. (auth)

18440 A SYSTEMS APPROACH TO CONTAINMENT DESIGN IN NUCLEAR POWER PLANTS. Levy, S. (General Electric Co., San Jose, Calif.). pp 227-42 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

A new approach is presented for establishing the performance requirements of containment designs in nuclear power plants. The approach recognizes that containment is only part of a total system, which prevents and limits the consequences of a release of fission products. Containment performance requirements are determined by looking at the overall system, rather than by making arbitrary assumptions about the source of the accident and the effectiveness of some of the provided features. The proposed technique is illustrated for the case of a loss-of-coolant accident in a large power boiling water reactor. The interrelationship of the pressure-suppression containment to other preventive measures is reviewed. The containment performance requirements are established as part of an overall system evaluation. Possible alternate containment features are evolved from the study. (auth)

18441 TECHNICAL ASPECTS IN THE CHOICE OF REACTOR SITES: A STUDY OF ACCIDENTS FOR THE NUCLEAR POWER STATION AT SAINT-LAURENT-DES-EAUX. Dennielou, Y.; Roche, R. (Electricite de France, Paris). pp 243-61 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The EDF4 nuclear power station at Saint-Laurent-des-Eaux, which is representative of the latest development in France of the natural uranium, gas, graphite-type of reactor with incorporated primary circuit is described. After a brief review of the characteristics of the power station, waste disposal in normal operation and after an accident is dealt with. The accidents considered when drawing up the safety report are described. Calculations show that in all the cases considered the doses released are lower than the permissible limit, so that this type of reactor could be installed close to a built-up area. (auth)

18442 RADIOECOLOGICAL CRITERIA IN PROTECTING THE SURROUNDINGS OF NUCLEAR SITES. Bovard, P.; Doury, A. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). pp 263-71 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Problems of safety arise from the inevitable possibility of intentional or accidental discharge of wastes or by-products into the different compartments of the environment, it is the processes of transfer and evolution undergone by these contaminating products in the environment in passing from the source to man–processes whose study is denoted by the modern concept of "radioecology"–that constitute the main part of present research programmes on the determination of safety criteria. After indicating the special significance of the dimensions and heterogeneity of the environment being studied, the main radioecological criteria for protection of the environment are evaluated, defined, and characterized. These criteria are classified in three main categories: preliminary surveys and investigations to determine various starting conditions, especially the contamination levels existing before operation of the installation: determination of the radiological capacity of the sites so that the experts concerned can decide on the best safety arrangements possible, account being taken of certain predetermined limitations; constant subsequent surveillance and monitoring of environmental contamination by approximate methods. 15 references. (auth)

18443 SUITABILITY OF THE ADVANCED GAS-COOLED REACTOR FOR URBAN SITING. Cave, L.; Holmes, R. E. (Atomic Power Constructions Ltd., Sutton, Eng.). pp 273-99 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The suitability of an advanced gas-cooled reactor (AGR) for an urban site is assessed in terms of the extent to which radioactive material would be released to the environment, both the normal operation and in fault conditions. It is shown that in normal operation the recommendations of ICRP can readily be met. The assessment of the effects of fault conditions takes two forms: assessment on the basis of maximum credible accident, and by estimating the upper limit to the potential fission-product release in each of the foreseeable primary fault conditions, together with an estimate of the probability of the release occurring for a typical AGR designed for an urban site. The relation between these expectations of release and the well being of the public is illustrated by an examination of their effects on the inhibitants of two typical sites. It is shown that an AGR without secondary containment is suitable for urban sites. The probability assessment shows that certain additional features are required which will not be necessary to meet the results of the assessment based on the maximum credible accident. (auth)

18444 CONTRIBUTION TO THE STUDY OF NUCLEAR REACTOR SITING IN THE NEIGHBORHOOD OF TOWNS. Lavie, J. M.; de Vathaire, F. (Centre d'Etudes Nucleaires, Saclay, France). pp 331-43 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Although the problem has not yet arisen in France, a survey is being made of the possibilities of constructing nuclear power stations in the vicinity of towns. The studies carried out in this direction are described; results of an inquiry into the distances between nuclear power stations and neighboring towns are given The safety factor introduced by distance is examined in relation to the population of the town. The consequences of large-scale release of radioactivity, corresponding to the maximum credible accident are analyzed. After specifying the data used for these evaluations, the consequences, as a function of the population of the town, in respect of three different levels of release and corresponding safety distances are evaluated. 18 references. (auth)

18445 NUCLEAR PLANT SITING FROM THE POINT OF VIEW OF ENGINEERING SAFETY EVALUATION. Iansiti, E.; Sennis, C. (Comitato Nazionale per l'Energia Nucleare, Rome). pp 345-63 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The main characteristics of a site which are relevant for selection of the most convenient location for nuclear power plants from the safety point of view are discussed. Important factors to be considered are earthquake hazards, flooding possibility, tornados, tsunamis and foundation stability. Other site characteristics such as soil retention properties and hydrology can also be reviewed, but always with reference to specific plant features. The factors associated with the exclusion area and population density around the plant need to be examined in the light of the safety assessment of a nuclear power plant as a whole. 22 references. (auth)

18446 THE DEVELOPMENT OF PRESSURE DIFFERENTIALS ACROSS CONTAINMENTS OF LARGE WATER-COOLED POWER REACTORS. Brosche, D.; Karwat, H. (Technische Hochschule, Munich). pp 365-81 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Full-pressure containments are designed to withstand a maximum pressure and temperature, which is calculated by steady-state calculations from an energy balance, taking into account the initial energy of the primary system, the fuel and possible chemical reactions which may occur as a consequence of the initiating reactor accident. The energy balance normally is done for the free volume of the containment, assuming thermodynamic equilibrium between water, steam and air with average values for the specific properties for the whole containment. There are, however, some processes during the dynamic loading of a containment to which, in our opinion, not enough attention has been given up to now. The sudden release of the high-energy primary coolant generates pressure waves and associated pressure differences across the containment which cannot be taken into account by steady-state calculations. Large containments normally are divided into several different sections in one of which the break of the primary system may happen. An analytical model has been developed by which the local pressure build-up is calculated, taking into account the subdivision of the containment, resistances which prevent the free exchange of mass and energy between the subsections, and the location of the primary system break. The model is based on mass, energy and momentum equations applied for each section. A description of the model is given in the paper. The energy source strength at the location of the break is based on appropriate two-phase-flow models such as Moody's or Fauske's. The equations are solved by digital computation. The results show where design or operational precautions have to be taken to made full pressure containments really safe. (auth)

18447 SOME EXAMPLES OF THE RELATIONSHIP BETWEEN CONTAINMENT AND OTHER ENGINEERED SAFEGUARD REQUIREMENTS, ACCIDENT ANALYSES, AND SITE CONDITIONS. Vinck, W. F.; Maurer, H. (Euratom, Brussels). pp 383-402 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Nuclear power reactors for which EURATOM has performed safety reviews in co-operation with national technical advisory organizations concerned in the licensing procedures are discussed. Comparative data are tabulated on a number of containment concepts and other engineered safeguards to protect against or to limit the consequences of major hypothetical accidents for a number of power reactors. Main environmental data, such as magnitudes of exclusion areas and population densities, are also presented. Emphasis is placed on containment, engineered safeguards and emergency equipment. These items are considered in general with emphasis on: the importance of meeting operability and high efficiency requirements (reliability) when needed through design and layout; periodic testing and/or inspection possibilities and requirements in order to maintain high availability standards. Attention is drawn to some difficulties which have arisen in connection with design, material choice and construction of steel containment structures and which in the interests of safety as well as of economic optimization justify in the future more care in the use of possibly uniform of single-code requirements. Examples of uncertainties encountered in some accident analyses and their influence on siting considerations are discussed, with emphasis on safeguards intended to retain radioactive material in the plant, such as extent of core damage, iodine plate-out, filtering efficiency, wash-out effects. The means by which some of the main uncertainties have been or can be eliminated through appropriate experimental programmes are discussed. Some examples are also given of the influence of factors which could be reasonably incorporated in accident model calculations, such as taking into account the influence of the post-incident pressure decrease on leak-rates from shell-type secondary containments. 24 references. (auth)

18448 ANALYSIS OF THE IMPROVEMENT IN SAFETY OBTAINED BY A CONTAINMENT AND BY OTHER SAFETY DEVICES FOR WATER-COOLED REACTORS. Kellermann, O.; Seipel, H. G. (Institut fuer Reaktorsicherheit der Tuev, eV, Cologne). pp 403-20 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Usually, a reactor containment is designed to sustain the maximum load that could arise from the worst credible accident. Because of the high quality standards in design, construction and inspection a containment failure under accident conditions is mostly believed incredible. Theoretical analyses and plant experience shows that a failure of the containment or some of its related components cannot completely be excluded. Since dangerous accidents are always initiated from failures in the cooling system or from unsafe physical core conditions, a study is made on whether it is possible and useful, without reducing the high standard of safety, to shift the safeguarding efforts from consequence-limiting systems such as a containment to additional safety factors in design, construction and inspection of reactor components and installation of very reliable and highly redundant devices, that prevent the escalation of any accident. The increase in safety to be gained by better design and improved reliability is discussed for reactor components, emergency core cooling systems and vapor containers. 24 references. (auth)

18449 CONTAINMENT FOR HEAVY-WATER GAS-COOLED REACTORS. Verstraete, P.; Lehmann, D.; Lafitte, R. (Bonard et Gardel, Ingenieurs-Conseils, Lausanne, Switzerland). pp 423-50 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The safety principles applicable to heavy-water, gas-cooled reactors are outlined, with a view to establishing containment specifications adapted to the sites available in Switzerland for the construction of nuclear plants. These specifications are derived from dose rates considered acceptable, in the event of a serious reactor accident, for persons living near the plant, and are based on meteorological and demographic conditions representative of the country's sites. Various designs for the containment shell are considered; the conditions which would exist in the shell after the maximum credible accident are examined. The following types of shell are studied: pre-stressed concrete with steel dome; prestressed concrete with inner, leakproof steel lining; steel with concrete side shield to protect against radiation; double shell. The degree of leakproofing of the shells studied is regarded as a feature of the particular design and not as a fixed constructional specification. The leakproofing properties of each type of shell and building costs for each of them is given on the basis of precise plans. They estimate the effectiveness of the various shells from a safety standpoint, in relation to different emergency procedures, in particular release into the atmosphere through appropriate filters and decontamination of the air within the shell by recycling through batteries of filters. A very detailed comparison of about 10 cases corresponding to various combinations of design and emergency procedure is given; the comparison was made using a computer programme specially established for the purpose. The results are compared with those for a reactor of the same type and power, but assembled together with the heat exchangers in a prestressed concrete shell. 11 references. (auth)

18450 CONTAINMENT OF A LARGE SODIUM-COOLED FAST-BREEDER REACTOR. Gast, K.; Schikarski, W. (Kernforschungszentrum, Karlsruhe). pp 451-62 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Containment requirements of nuclear reactors depend on the course and effects of large accidents. Those accidents are governed by nuclear, thermodynamic and chemical processes. Whereas in thermal reactors of the water-cooled and gas-cooled type essentially thermodynamic effects control the large accidents, in sodium-cooled fast reactors thermodynamic and nuclear events are significant. Following the conceptual design study for a 1000-MW sodium-cooled fast-breeder reactor, the conceptual design of a 300-MW prototype reactor is currently underway at Karlsruhe Research Center. For the prototype reactor, a rather conservative safety assessment was chosen to compensate for incomplete knowledge of detailed nuclear and thermodynamic behavior in a large accident. Double containment will therefore be provided, the inner containment being designed for the potential consequences of a nuclear excursion with destructive energy release, and for prevention of large sodium fires. The outer containment will serve as a final barrier for fission products and other radioactive aerosols. The containment concept is aimed at independence in site selection. For future commercial fast-breeder reactors double containment is not expected to be necessary any more as more information by a special programme will become available on the accidental behavior of large sodium-cooled fast reactors and on the reliability of engineered safeguards. (auth)

18451 METHODS OF CONTAINMENT ADOPTED FOR THE EL4 REACTOR AND PROJECTED HEAVY-WATER, GAS-COOLED PLANTS. Schulhof, P.; Justin, F. (Commissariat a l'Energie Atomique, Paris). pp 463-71 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

After a brief description of the plant, the paper explains the principles adopted for preventing the release of waste gas from the EL4 reactor and refers to some of the difficulties associated with this type of containment. From the economic standpoint, the results of a comparative civil engineering study of prestressed concrete and steel shells for a projected 60 MWe power station are given. 14 references. (auth)

18452 CHECKING OF THE LEAKAGE RATE FROM THE LEAKPROOF BUILDING OF THE BR-2 REACTOR. Leonard, F.; Carteus, M.; Boonen, P. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). pp 487-507 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The containment building of the BR-2 reactor is briefly described; procedures for leak rate testing are presented in graphic form; data reduction methods are discussed. (M.L.S.)

18453 CONTAINMENT OF AN ADVANCED GAS-COOLED REACTOR. Cave, L.; Bracewell, G. M. (Atomic Power Constructions Ltd., Sutton, Eng.). pp 509-25 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The inherent features of the advanced gas-cooled reactor (A.G.R.) which serve to retain fission products within the system are described. The roles played by the fuel, fuel-can and primary pressure circuit are discussed and illustrated by reference to the Dungeness "B" reactor design. Some possible additional safety features are described. The effects of possible fault conditions on the retention of fission products within the system are discussed and the extent to which the safety of the reactor depends on design features is evaluated. It is shown that the A.G.R. system provides an exceptionally high degree of safety without the provision of a conventional pressure-retaining secondary containment. 13 references. (auth)

18454 STEAM-GENERATING HEAVY-WATER REACTOR: ITS DESIGN, CONTAINMENT, AND SAFETY CHARACTERISTICS. Johnson, F. G.; Poulter, D. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 545-67 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

A brief description of the principal features of the reactor system and the general objects of the design, with particular reference to the prototype recently constructed at Winfrith Heath, Dorset, is given. The research, development, design and analytical work carried out in connection with some of the more important features of the reactor, including containment, are outlined, along with the measures adopted during construction, testing and commissioning to support the safety principles. An indication of how the safety analysis is related to the probability approach is given, together with some comments on the application to future designs of the work carried out for the prototype and of the features adopted in the design. 11 references. (auth)

18455 LEAKAGE RATE TESTING OF CONTAINMENT VESSELS BY THE REFERENCE METHOD. Boedege, R. J. (Kernkraftwerk Lingen GmbH, Dortmund, Ger.). pp 569-85 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The various methods which have been used in leakage rate testing are briefly described and compared. The formulae for the leakage rates of the absolute and reference system are derived from thermodynamics. Application of the reference method is made to the Gundremmingen Power Reactor; results are given. The merits of the reference system are evaluated. (M.L.S.)

18456 RECENT FRENCH EXPERIENCE IN PREVENTING THE ESCAPE OF RADIOACTIVE WASTES AT NUCLEAR POWER PLANTS. Candes, P.; Lavie, J. M. (Commissariat a l'Energie Atomique, Paris). pp 587-95 of Containment and Siting of Nu-

clear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In French).
From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The advances in the French program for the planning of containment for nuclear power plants are evaluated. Experimental studies are discussed; impact of results of these studies is analyzed. (M.L.S.)

18457 SAFETY FEATURES OF THE HINKLEY POINT B AGR PRESSURE VESSEL AND PENETRATIONS. Yellowlees, J. M.; Spruce, T. W. (The Nuclear Power Group Limited, Knutsford, Eng.). pp 597-617 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.
From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The concrete pressure vessel surrounding an AGR has penetrations through its walls for the gas circulators, steam and feed pipes, control rods and refuelling system and for various services. Retention of the high-pressure gas coolant within the pressure vessels depends on the continuing integrity of these penetrations. The large penetrations in the vessel walls of an AGR of the Hinkley Point B type are detailed; the criteria governing their design, construction and operation are described. Arguments are presented which lead to the conclusion that the penetrations, when appropriately designed and constructed, can have sufficient integrity for an AGR to be sited in a densely populated area. 9 references. (auth)

18458 "TO CONTAIN, OR NOT TO CONTAIN." Wolff, P. H. W. (Nuclear Design and Construction Limited, Whetstone, Eng.). pp 619-30 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.
From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The reactor system offering least potential hazard is clearly one which by virtue of its inherent design is incapable of allowing the release of radioactive material from within the system during normal operation or under any credible fault conditions. The departure of real systems from this ideal standard may be such as to require a secondary system of containment to prevent the escape of radioactive material in unacceptably large quantities: alternatively, the reactor system may be inherently capable of being constructed in such a manner that the release of radioactive material does not exceed tolerable levels under all normal or fault conditions and hence no secondary system of containment is required. The latter has been the conclusion reached for the gas-cooled civil nuclear power stations so far constructed in the United Kingdom. The approach requires the behavior of the reactor system to be known under all conditions and the extent to which this is possible is illustrated by discussion of the design solutions adopted to prevent the escape of radioactive material from the Advanced Gas-Cooled Reactors at present under construction for the second phase of the British Nuclear Power Programme and for the Steam-Generating Heavy-Water-Moderated Reactor, Sodium-Cooled Fast Reactor and High-Temperature Gas-Cooled Reactor prototypes and power designs under development in the United Kingdom. Some reference is also made to the design problems encountered in other systems. (auth)

18459 TRAPPING OF IODINE IN WATER POOLS AT 100°C. Devell, L.; Hesboel, R.; Bachofner, E. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 633-45 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.
From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Experiments and calculations on trapping of elemental iodine in laboratory and large scale boiling water pools are described. Variable parameters are pH, iodine concentration and mass transfer conditions. After reaction of molecular iodine with water, a certain fraction, determined by pH and iodine concentration, is retained as elemental iodine. This part is available for release with exhausted steam according to the partition properties of elemental iodine. Laboratory experiments show that reestablishment of chemical equilibrium did not seem to occur when elemental iodine is removed from the water pool. Thus, practically, the fraction first hydrolysed is permanently trapped. Results from the large scale study are in agreement with these findings and show that superheated steam, under certain conditions, can be effectively decontaminated from iodine even by a boiling water pool with no net steam condensation capacity. Equations for predicting two-phase transfer of volatile iodine as a function of physical parameters are developed and tested. 9 references. (auth)

18460 ADSORPTION OF GASEOUS METHYL IODIDE BY ACTIVE CARBONS. Cornelissens, E. G. P.; van der Lugt, G.; van der Plas, Th. (Euratom-RCN-Kema Reactor Development Group, Arnhem, Netherlands). pp 647-54 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.
From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The impregnation of active carbons is known to be a useful means of improving the ability of these carbons to retain methyl iodide (CH_3I) which might be formed during the accidental release of fission products from a reactor. Some basic work was done on both impregnated and unimpregnated materials, which involved: the texture; the reaction of CH_3I with the impregnants; the adsorption of CH_3I on the carbons under dry and wet conditions at different temperatures. It was found that the carbons are highly microporous. A large part of this porosity disappears on impregnation with organic amines. These impregnants react chemically with the methyl iodide, which is thereby fixed on the carbon. For carbon which is impregnated with KI, a rapid exchange reaction takes place between the methyl iodide and KI under both dry and wet conditions. Consequently most of the iodine activity can be removed from the gas. 10 references. (auth)

18461 TESTING OF REACTOR FILTER SYSTEMS IN THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY. Beattie, J. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 655-61 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.
From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The methods currently in use or under development for testing filter and absorber systems installed on reactors in the United Kingdom Atomic Energy Authority are discussed and some results for operational filter and absorber systems are presented. 10 references. (auth)

18462 FISSION-PRODUCT REMOVAL FOR REACTORS WITH VENTED CONTAINMENT. Abbey, F. (United Kingdom Atomic Energy Authority, Risley, Eng.); Hillary, J. J. pp 663-79 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.
From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

In one form of low-pressure vented containment the reinforced concrete biological shield forms the primary containment. If the coolant circuit ruptured, steam in the primary containment would be vented to pipes submerged in a deep-water pond situated in a compartment of the secondary containment. In the experimental work described, large-scale engineering rigs were used to investigate the removal of iodine and aerosols from steam-air mixtures discharged into water. The results are presented. 17 references. (auth)

18463 METHODS FOR THE REMOVAL OF RADIOACTIVE IODIDES ADOPTED IN FRANCE. Billard, F. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). pp 681-98 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In French).
From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Recent studies by British and American scientists have disclosed the presence of penetrating forms of iodine, especially methyl iodide, in fission products released after reactor accidents. The efforts made to establish which of the various methods proposed for the removal of these nuclides are suited to conditions in France are discussed. The results of a study on the trapping of methyl iodide with activated carbons impregnated with potassium iodide or triethylene diamine are given. The auxiliary equipment which it has been decided should be incorporated in reactors and the methods of inspection adopted both for manufacture and for use in situ are described. 30 references. (auth)

18464 EXPERIMENTAL STUDIES ON PREVENTING THE ESCAPE OF CONTAMINATION AFTER A NUCLEAR ACCIDENT. Barthoux, A. (Centre d'Etudes Nucleaires, Cadarache, France). pp 699-714 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967. (In French).
From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The French programme of experimental studies on the release and dissemination of radioactive contamination in the event of a serious reactor incident is designed to ensure more accurate assessment of plant safety factors and at the same time bring about a more satisfactory and generally more economic definition of containment. The first stage consists in establishing the type and rate of contamination which might occur within the shell in the event of simultaneous failure of the fuel and the primary loop. Various experiments have been carried out to determine the path followed by products in the primary loop. Thus: a fuel melting experiment in the CABRI reactor showed a very high rate of retention in the water, but also provided evidence of the very penetrating nature of the iodine compounds released from the water; an investigation of the melting of irradiated uranium in liquid sodium produced a partition coefficient for sodium and its vapor, with a volumetric concentration ratio of about 10^{-5}; and samples taken from gas loops containing damaged fuel elements provided information on the various iodine compound. The results already obtained show high safety factors, which are indicated and discussed. (auth)

18465 SITING OF NUCLEAR POWER PLANTS IN METROPOLITAN AREAS: ESTIMATION OF POPULATION DOSES DUE TO ACCIDENTAL RELEASE OF FISSION PRODUCTS. **Bresser, H.; Schwarzer, W. (Technische Ueberwachungs-Verein eV, Cologne). pp 735-51 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.**

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The safety of large nuclear power plants in heavily populated areas depends entirely on engineered safeguards. An assessment of their reliability and effectiveness will have to play a major role in any safety analysis of such a plant, and this assessment will have to be made on the basis of the radiological burden to the environment which can be accepted as tolerable in case of a severe accident. The calculation of the dispersion of fission products in the atmosphere, which links the radiological burden to the release of radioactivity, should be modified. The fact that distance factors, aside from a comparably small exclusion area, can no longer be taken into account suggests the introduction of the parameter population density and an extensive use of the man-rem concept. In this connection the time history of the release and the influence of variations of wind directions lose their importance. Calculations of the population dose, which could be received in a metropolitan area as a consequence of a severe reactor accident, using population densities, height of release above the ground and generalized meterological data as the main parameters are given. The results of these calculations are used as a basis for an assessment of the performance requirements of the engineered safeguards system, and the relative importance of different components of this system is discussed. (auth)

18466 SITE SELECTION FOR NUCLEAR POWER PLANTS: GUIDES FOR ESTIMATION OF CONSEQUENCES DUE TO THE RELEASE OF CONTAMINATED AIR AND WATER DURING NORMAL OPERATION. **Bresser, H.; Dick, C.; Lindackers, K.-H.; Tscherner, M. (Technische Ueberwachungs-Verein eV, Cologne). pp 753-71 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.**

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The radiological burden in the environment of a nuclear power plant due to the release of contaminated air during normal operation should not exceed the maximum permissible annual doses recommended by the International Commission on Radiological Protection (ICRP) or national regulations. On the basis of standardized annual frequency distributions of the different dispersion categories, maximum permissible source strengths for characteristic isotopes or isotope mixtures are calculated as a function of source height above ground. The results are discussed from two particular viewpoints: special site conditions (valley); different power reactor types. As to the disposal of liquid waste, the general practice is to discharge contaminated water together with cooling water into available surface waterways. This procedure is limited not only by the necessary radiological protection of the aquatic environment but also by the maximum tolerable temperature rise of the river water, which in turn depends on the public use of the entire river. Utilization categories for different types of rivers and calculations of the permissible waste water quantities, their temperature and activity concentration as a function of the above-mentioned utilization categories, the flow capacity of the river at the point of discharge and of the distance to the nearest drinking water plant or coolant supply are calculated. The requirements of measuring and recording equipment for the monitoring of contaminated air and water to be released are discussed briefly. A special effort is made to present the results in a series of diagrams and forms such that they can be used in a simple manner for site selection and licensing procedure of nuclear power stations in the Federal Republic of Germany. 18 references. (auth)

18467 INFLUENCE OF THERMAL POLLUTION ON NUCLEAR POWER PLANT SITE SELECTION. **Stobbs, J. J.; Pekarek, H. J. (Electro-Watt Engineering Services Ltd., Zurich). pp 773-90 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.**

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The efficient operation of thermal power stations requires considerable quantities of cooling water, and it is thus both logical and economical where possible to site them on suitable rivers where adequate cooling supplies exist. As in many countries where the number of suitable rivers and sites is limited, concern has recently been growing over possible thermal pollution in view of widespread plans for future large installed electrical generating capacities. Interest lies in both the increase in river temperature and the time it requires to return to or approach its original temperature in order to determine the most favorable utilization of hydraulic resources. A mathematical model is presented which describes temperature changes in rivers as a result of shortwave radiation from the sun, long-wave radiation from the water and from the atmosphere, evaporation from the water, conduction between the water and the atmosphere and vice versa, and finally advected heat from rainfall, tributaries and power plant discharge. The equations have been incorporated in a computer code whose input data is simple power plant, geographical and meteorological information and which enables the rapid determination of temperature profiles of shallow, slow-flowing rivers. A detailed description of the programme is given and sample input and output sheets are presented. The application of the code is demonstrated for the case of the Rhine waters in northern Switzerland, where a considerable number of nuclear power projects are being built and planned. It is shown that under average summer conditions the amount of capacity to be sited on the Rhine up to the year 2000 should not cause undue thermal pollution of the water. 6 references. (auth)

18468 ENGINEERING DETAILS OF SGHWR, WINFRITH [U. K.]. **Engineer, 225: 398-9(Mar. 8, 1968).**

Details of the design described include the pressure tubes, the refueling machine and associated rotating shields, and the pressure suppression system. A list of the major contractors is included. (UK)

18469 DESIGN OF THE CONCRETE CONTAINMENT VESSEL FOR THE R. E. GINNA NUCLEAR POWER PLANT. **Lorenz, Hans (Gilbert Associates, Inc., Reading, Pa.). Nucl. Eng. Design, 6: 360-6(1967).**

Description of the design of the concrete containment vessel for the R. E. Ginna Nuclear Power Plant, Rochester, New York, is given. The vessel consists of a 105 ft diameter vertical concrete cylinder of 99 ft height with a hemispherical dome. Emphasized are special features such as prestressed rock anchors, neoprene hinges at the base of the vessel and vertical post-tensioning of the cylinder walls. (auth)

18470 ANALYSIS OF ON-LINE IDENTIFICATION AND CONTROL OF A NUCLEAR REACTOR. **Swanick, B. H.; Graupe, D. (Univ. of Liverpool). J. Brit. Nucl. Energy Soc., 7: 100-13(Jan. 1968).**

An on-line digital control system is proposed for a reactor system. The derivation of the reactor model is given in some detail and its validity is tested against actual data from the Universities Research Reactor at Risley, England. After building a satisfactory model of the reactor, various on-line techniques are incorporated into the plant operation. Optimization, estimation of inaccessible outputs, and an identification technique are included, together with a scheme for their practical adoption. (auth)

18471 FURTHER REACTOR PHYSICS STUDIES FOR STEAM GENERATING HEAVY WATER REACTORS. PART I. UNIFORM CLUSTER LATTICES CONTAINING UO_2 OR PuO_2/UO_2 FUEL. **Briggs, A. J.; Johnstone, I.; Kemshell, P. B.; Newmarch, D. A. (Atomic Energy Establishment, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 7: 61-90(Jan. 1968).**

As part of the study of SGHW lattices, a wide range of uniform cluster arrays was studied. Both enriched UO_2 and PuO_2/UO_2 fuels were used, and the range included pin diameters from 0.3 in. to 0.5 in. in clusters which contained from 37 to 90 pins each. Measurements of material buckling, detailed reaction rates and void coefficient are compared with theoretical predictions using METHUSELAH II, which is an improved version of the five-group diffusion theory code, METHUSELAH I, originally developed for

SGHW assessment and design studies, and the 69-group, transport theory code, WIMS, which has superseded THULE. (auth)

18472 THE DESIGN OF THE STEAM GENERATING HEAVY WATER REACTOR. Cartwright, H. (United Kingdom Atomic Energy Authority, Risley, Eng.). Atom, No. 136, 26-37(Feb. 1968).

The main design features are reviewed, and a discussion is included on the way in which the unitised system of construction of reactor parts, and concentration on off-site manufacture, can be applied to larger commercial units. The required type of manufacturing facilities is also mentioned. It is pointed out that the engineering of the reactor is based on conventional techniques. Scope is offered for building reactors of different outputs, using the same dimensions for channel tube assemblies and for fuel elements, thus enabling advantage to be gained from repetition in production methods. It is considered that the experience gained in the development, design and construction of the prototype has fully established the engineering of this advanced reactor system. (UK)

18473 GAS BLOWERS FOR ST. LAURENT 1. Feer, K.; Benz, H. (Sulzer Bros., Ltd., Winterthur, Switzerland). Nucl. Eng., 13: 119-24(Feb. 1968).

The blowers, 8 of which are ordered for the St. Laurent reactors, are 16 MW mixed-flow machines with a flow rate of 2,246 kg/s at a speed of 2,790 rpm. The design of the blowers is described in detail, and the strength and aerodynamic test programmes are summarised. Test stand trials in a pressure chamber gave full satisfaction. (UK)

18474 REPORTS FROM WORLD NUCLEAR POWER STATION SITES. Nucl. Eng., 13: 202-14(Mar. 1968).

Progress reviews on work at the principal reactor sites are presented. A chart summarizes the planning, construction, and operating history of the 206 known power station plants. (UK)

18475 STUDIES ON THE EVALUATION ERRORS IN ROD-DROP EXPERIMENTS. Koehler, B. (VEB Kernfraftwerksbau, Berlin). Kernenergie, 10: 331-6(Nov. 1967). (In German).

In power reactors the variation of spatial neutron flux distribution usually neglected in rod-drop experiments shows essential influence on the result of measurements. As an example, this influence is studied by expansion in eigenfunctions as well as by utilizing space-time synthesis. An expression is derived for correcting the measured values so that useful results of the reactivity of the control rods can be obtained. (auth)

18476 LONG-TIME BEHAVIOR OF FAST BREEDERS. Reiche, Ch. (Zentralinstitut fuer Kernforschung, Dresden). Kernenergie, 10: 292-8(Oct. 1967). (In German).

The long-time behaviour of fast breeders having various sizes and composition with carbide, oxide, or metallic fuel has been studied. Especially, the isotopic composition, conversion factors, and net refueling currents have been calculated for the steady state. (auth)

18477 THE FUTURE OF NUCLEAR POWER AS SEEN FROM THE UNITED KINGDOM. Penney, William. pp 47-57 of Scientific Progress and Human Values. Hutchings, Edward; Hutchings, Elizabeth (eds.). New York, American Elsevier Publishing Co., Inc., 1967.

From Conference on Scientific Progress and Human Values, Pasadena, Calif. See CONF-661058.

The outlook for the growth of nuclear power stations during the next decade is reviewed using the experience to date and anticipated needs of the United Kingdom. Economics, fuel supplies and demand, and safety factors involved in the growth of nuclear power are discussed. (H.D.R.)

18478 ON-LINE STATISTICAL IDENTIFICATION OF NUCLEAR POWER REACTOR DYNAMICS. Ciechanowicz, W.; Bogumil, S. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Sci. Eng., 31: 474-83(1968).

On-line statistical identification of the nuclear reactor processes has been considered theoretically. These techniques are not time consuming and enable decreasing the uncorrelated noise effect in the overall measured noise if only the output signal of the system is accessible for the measurement. The assumption has been made that process dynamics are approximated by single time-constant transfer functions. The postulated techniques have been based on proper filtering of the process spectral power. The auto-correlation and cross-correlation functions for the zero time lag have been applied to assignment of the spectral power. It has been shown that the proposed identification techniques enable: determination of the process dynamics in a unique way by making use of the correlation functions for the zero time lag even when the process dynamics is characterized by more than one time constant; and a decrease in the contribution of the uncorrelated noise in the overall measured noise when the cross-correlation technique cannot be used. (auth)

18479 THE STATE OF ATOMIC ENERGY TODAY: VIEWS ON ITS DEVELOPMENT ABROAD AND AT HOME. Ager-Hanssen, H. (Institutt for Atomenergi, Kjeller, Norway). Tek. Ukebl., 114: 848-54(Dec. 14, 1967). (In Norwegian).

The rapid development of nuclear power in the United States is described. Short descriptions of the boiling and pressurized water reactors are given together with indicative cost figures. How the reactor manufacturers and the utilities meet the challenge represented by the "atomic boom" is then briefly discussed, and indications on the possible further technological development are given. The necessity of the development of advanced reactors is discussed in relation to the uranium resource problem. Finally, the introduction of economic nuclear power in Norway is discussed. (auth)

18480 PRESSURIZER PERFORMANCE DURING LOSS-OF-LOAD TESTS AT SHIPPINGPORT: ANALYSIS AND TEST. Redfield, J. A.; Prescop, V.; Margolis, S. G. (Westinghouse Electric Corp., West Mifflin, Pa.). Contract AT(11-1)-Gen-14. Nucl. Appl., 4: 173-81(Mar. 1968). (WAPD-T-1959).

A computational model, based on a rigorous application of the first law of thermodynamics together with heat and mass transfer laws, makes no a priori assumptions concerning the thermodynamic path of the process. This method has been reduced to practice in a digital computer program called TOPS. Transient primary pressures for three load-drop transients at Shippingport agree well with calculations using the TOPS model. The model is particularly useful in predicting the effects of spray systems and heater operation on plant pressure transients. (auth)

18481 ON TRANSIENT DIGITAL CONTROL OF LARGE NUCLEAR POWER REACTORS. Ciechanowicz, W. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Sci. Eng., 31: 465-73 (1968).

The formulation of the transient digital control problem of power reactors is discussed. Simplifications have been considered that have to be made to enable modern control theory to be applicable for use in digital control. Included in the discussion are the approaches of digital control systems that would satisfy stability, autonomy, and optimal filtering criteria. The aim is to propose possible solutions of the considered problem and further investigations. 25 references. (auth)

18482 THE ROLE OF HEAVY WATER ADVANCED CONVERTERS IN A MIXED FAST AND THERMAL SYSTEM. Zorzoli, G. B. (CISE, Milan). Energ. Nucl. (Milan), 14: 693-703 (Dec. 1967).

Reference is made to a power system, based on both heavy water advanced converters and fast breeders, and with a given law of expansion with time. Each class of reactor is defined by the following parameters: fuel inventory, conversion ratio, irradiation period, capital and fuel costs. An average load factor for the whole system and for the fast breeders is assigned. The maximum fast breeder penetration, allowed by the amount of extra-plutonium from both fast and thermal plants, is evaluated either accounting for delays and losses or neglecting it. The economics of the mixed system is compared with the one of a pure thermal system, when natural uranium fuel fabrication and reprocessing costs are both variable and constant. As an index of comparison, the plutonium price equalizing power costs of either reactor type is assumed. Calculations are performed over the whole range of reasonable variation for the parameters defining each class of reactor and the system characteristics, so as to allow a comprehensive picture of the options acceptable on an economic basis. (17 references) (auth)

18483 NUCLEAR REACTOR CHANNEL WITH ZIRCONIUM ALLOY PRESSURE TUBE AT OPTIMUM OPERATING TEMPERATURE. APPLICATION TO A REACTOR COOLED WITH ORGANIC LIQUID. Farfaletti-Casali, F.; Montagnani, M. (EURATOM, Ispra, Italy). Nucl. Eng. Design, 6: 465-78(1967).

A confrontation with problems relating to the development of a pressure tube for an organic cooled heavy water moderated reactor (ORGEL type) lead to a preliminary study of a channel which would utilize known Zr alloys in a safe temperature range. This concept has not been further developed. H_2 absorption (with consequent embrittlement) in Zr alloys in contact with coolants releasing H_2, such as organic liquids, increases rapidly with the operating temperature. In the proposed solution the control of the H_2 absorption is achieved by limiting the temperature of the pressure tube. The proposed solution also avoids the use of Zr alloys at a too low temperature. By means of two insulating layers, one outside the fuel element and the other between the pressure tube and the moderator, the temperature of the pressure tube is kept low enough to avoid hydrogenation, while at the same time remaining above the ductile-brittle transition temperature of the material. The thermal insulant on the fuel element also acts as its supporting structure, and largely protects the cans against mechanical stresses. Some solutions are presented, together with the relevant considerations, particularly in relation to reactors cooled with organic liquid. (auth)

18484 NUCLEAR PLANT EMERGENCY POWER. **Power Eng., 72: 62-5(Feb. 1968).**

Emergency power systems designs for a 1000 MW(e) PWR and a 762 MW(e) BWR are given. Schematics are shown for the basic BWR and PWR systems; the basic logic diagram for an emergency diesel generator system for the PWR is given; a one-line diagram for the uninterruptable ac power supply for a BWR is shown. These power systems are discussed briefly. (M.L.S.)

18485 NUCLEAR PLANT PROTECTIVE SYSTEMS. **Nathan, A. (Sargent and Lundy, Chicago). Power Eng., 72: 45-8(Feb. 1968).**

The protective systems for nuclear power plants are described. Instrumentation required for source (or startup), intermediate, and power range operation is discussed; block diagrams summarize the needs for each range. The self-regulating feature of commercial power reactors is described. The interconnections of the reactor and steam plants are considered. (M.L.S.)

18486 JOURNEES INTERNATIONALES D'ETUDE DES CENTRALES ELECTRIQUES MODERNES, DU 23 AU 27 MAI 1966. TOME I. (International Symposium for the Study of Modern Electrical Power Stations (Hydro, Thermal, and Nuclear). Volume I). Liege, Electrotechnique Montefiore, 1966. 566p. (CONF-660552-Vol.1).

Included are 48 papers on the technical and economic development of modern electrical power stations. Individual abstracts were prepared for 12 papers on various aspects of nuclear power reactor development. (H.D.R.)

For abstracts of individual papers see: 18487–18498.

18487 TURBINES FOR BRITISH NUCLEAR POWER STATIONS. Gray, J. L. pp 15.1-7 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome I. Liege, Electrotechnique Montefiore, 1966.
From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.1.

The work in Great Britain on turbines for nuclear power stations utilizing various reactor types is reviewed. The thermodynamic cycles of the various types of station are outlined and their implications for turbine design are discussed. Practical designs evolved to deal with dual steam pressure, variations in volumetric flow, steam wetness, and temperature gradients are described. (H.D.R.)

18488 STEAM TURBINES FOR NUCLEAR POWER PLANTS. Brazzini, R. (Electricite de France, [Paris]); Nifenecker, M.; Widmer, M. pp 16.1-7 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome I. Liege, Electrotechnique Montefiore, 1966. (In French).
From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.1.

The thermodynamic characteristics of the French nuclear power stations using gas cooled reactors are tabulated. Economic and size factors involved in turbine development are reviewed, and operating parameters of large turbines are discussed. Future development of turbines on the order of 600 MW is examined. (H.D.R.)

18489 SOME PROBLEMS RELATING TO SATURATED STEAM TURBINES FOR NUCLEAR POWER PLANTS. Hohl, R. pp 17.1-7 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome I. Liege, Electrotechnique Montefiore, 1966. (In French).
From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.1.

As nuclear power stations are generally only economical in the range of 300 to 600 MW and due to the prominence of boiling water reactors, pressurized water reactors and gas cooled reactors, the turbine makers are induced to develop adequate saturated steam turbines. Important problems are involved, such as large volume of waste steam, draining, protection against erosion, moisture separators, reheater heated by steam, interception valves, overspeed caused by tripping, and choice of speed between 3,000 and 1,500 rpm. It is shown that many conditions oppose one another and that optimizing such turbines requires careful balance of the eventual solutions of compromise. (auth)

18490 NUCLEAR TURBINE DESIGN: RECENT REALIZATIONS AND VIEWS FOR THE FUTURE. Riollet, G. pp 18.1-15 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome I. Liege, Electrotechnique Montefiore, 1966. (In French).
From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.1.

The construction of nuclear turbines reflects the relatively moderate conditions of the steam delivered from present nuclear heat sources. In effect, this situation assigns to the design of turbine sizes a preponderance to low pressure units and confers an essential role to exhaust losses and vacuum quality in the consideration of energetics. Therefore, it is necessary to perform an economic analysis that fixes these two fundamental parameters before proceeding with a study of a nuclear unit. Added to these basic factors, the increase in rating of a unit leads to a considerable development effort on the exhaust section from the need to perform a complete examination of risks of erosion of the rear blades and requires a study of appropriate structures which allow the turbine dimensions to be limited. From this viewpoint, some of the characteristics of the 288 MW turbine installed at the Chooz power station and some plans capable of satisfying the large power units of the future are described. (tr-auth)

18491 STEAM TURBINES FOR NUCLEAR POWER PLANTS. Lenz, H. (Brown, Boveri and Co., Ltd., Baden, Switzerland). pp 19.1-6 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome I. Liege, Electrotechnique Montefiore, 1966. (In French).
From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.1.

A survey of the present design proposed by Brown Boveri for steam turbines as required for modern nuclear power plants using saturated steam, especially the measures taken to avoid damages caused by the high moisture, is given. (auth)

18492 DESIGN OF STEAM TURBINES FOR NUCLEAR POWER STATIONS. Sinton, Walter (Westinghouse Electric Corp., Philadelphia). pp 20.1-6 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome I. Liege, Electrotechnique Montefiore, 1966.
From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.1.

Described are some of the steam turbines designed by Westinghouse for application with water cooled reactor plants. A brief resume of applicable thermal cycles is included. Moisture removal devices are reviewed. Various turbine configurations are described and discussed. Maximum ratings are related to multiples of last row blade height. A description of a 650 MW, 3000 rpm, tandem-compound 4 casing turbine with sextuple 33.5 inch last row blades is included. (auth)

18493 CONTRIBUTION OF REACTOR TO THE FUTURE ENERGETIC DEVELOPMENT. Calberg, G. (Bureau d'Etudes Nucleaires, Brussels). pp 35.1-15 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome I. Liege, Electrotechnique Montefiore, 1966. (In French).
From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.1.

The technological evolution of light water reactors is reviewed, and some characteristics of boiling-water and pressurized-water power reactors under construction are tabulated and discussed. Trends of future development are examined, and economic aspects of power reactor type, size, and fuel cycle are discussed. The position of European industry in light-water power reactor development is summarized. (H.D.R.)

18494 NUCLEAR POWER STATIONS WITH GAS COOLED REACTORS. Saitcevsky, B. pp 36.1-16 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome I. Liege, Electrotechnique Montefiore, 1966. (In French).
From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.1.

The characteristics of gas-cooled graphite-moderated reactors are examined from the standpoint of their development on a commercial scale. After a short historical review, the evolution of the basic concept of this reactor type, operating experience, economic aspects, and future development are discussed. (H.D.R.)

18495 TECHNICAL AND ECONOMICAL ASPECTS INHERENT TO SMALL POWER REACTORS. Theys, Michel. pp 37.1-13 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome I. Liege, Electrotechnique Montefiore, 1966. (In French).

From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.1.

The worldwide development of small power plants is reviewed, and economic factors favoring the use of small power reactors are discussed. Some of the technical characteristics of such reactors are examined, and the prototype spectral shift Vulcain reactor is briefly described. (H.D.R.)

18496 HEAVY WATER REACTORS: RESULTS AND PERSPECTIVES. Bahbout, A.; Leny, J. C. pp 38.1-23 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome I. Liege, Electrotechnique Montefiore, 1966. (In French).

From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.1.

The economic and political advantages relating to the long range nuclear program of heavy water reactors are reviewed. A short outline of the most representative types under study in Western Europe is given. The performances in terms of overall net efficiency, fuel burn up, specific investment in heavy water, etc., are discussed and the main problems relating to each line are stressed. The perspectives of development—on the one hand, those common to the whole family of reactors and, on the other hand, those relating to each method of cooling—are also reviewed and discussed. (auth)

18497 RECENT DEVELOPMENTS IN THE EUROPEAN FAST REACTOR PROGRAMME. Jackson, G. O. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 39.1-9 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome I. Liege, Electrotechnique Montefiore, 1966.

From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.1.

The economic position of fast reactors in Britain is reviewed with respect to other sources of electrical power generation. It is concluded that, provided 60,000 MWd/tonne burn up can be achieved, as many fast reactors as the plutonium supply will allow should be installed once the prototype has proved itself. The Prototype Fast Reactor to be built in the U.K. is described and the areas where development work is required or being carried out especially by industry as opposed to the U.K.A.E.A. itself are discussed. It is indicated particularly that industry is being asked to produce tubing, wrappers and grids for the core subassemblies, new materials for shielding rods and to create new techniques for boiler tube/tube plate welding. Finally, it is concluded that sodium cooled fast reactors can be sited safely in built-up areas, to give steam conditions that are now common in fossil fuel driven turbines. (auth)

18498 PROSPECTS FOR COMPETITIVITY OF ELECTRICAL GENERATION FROM NUCLEAR POWER. Boxer, L. W. (European Nuclear Energy Agency, Paris). pp 40.1-13 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome I. Liege, Electrotechnique Montefiore, 1966.

From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.1.

A broad assessment of the role of nuclear energy as a competitive means of large-scale power generation is presented, with the primary emphasis on the Western European area. Operating experience, economics, and future development potential are discussed for gas-cooled graphite-moderated reactors, light-water reactors, and heavy-water moderated reactors. (H.D.R.)

18499 JOURNEES INTERNATIONALES D'ETUDE DES CENTRALES ELECTRIQUES MODERNES, DU 23 AU 27 MAI 1966. TOME II. (International Symposium for the Study of Modern Electrical Power Stations (Hydro, Thermal, and Nuclear). Volume II). Liege, Electrotechnique Montefiore, 1966. 255p. (CONF-660552-Vol.2).

Included are 6 sections of discussions by various members of the symposium on thermal, hydro, and nuclear central power station development and economics. An abstract was prepared for the discussions on power reactors. (H.D.R.)

For an abstract of the individual section see: 18500.

18500 NUCLEAR POWER PLANTS. pp 171-245 of Journees Internationales d'Etude des Centrales Electriques Modernes, du 23 au 27 Mai 1966. Tome II. Liege, Electrotechnique Montefiore, 1966. (In Several Languages).

From International Study Days on Modern Electrical Power Stations, Liege, Belgium. See CONF-660552-Vol.2.

Discussions by various participants in the symposium are presented on the development of nuclear power plants. Technical and economic aspects of boiling-water, pressurized-water, gas-cooled, and fast breeder reactors are examined, and their influence on future energy development is discussed. The nuclear power program of the U.K. Atomic Energy Authority is reviewed, with particular emphasis on Magnox and AGR development. (H.D.R.)

18501 FAST BREEDER REACTORS. Proceedings of the London Conference, London, 17–19 May 1966. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967. 959p. £ 12. (CONF-660502).

The 37 papers presented relate to the place of the fast breeder reactor in energy programmes, operating experience with fast reactors, design of prototypes and power reactors, reactor physics, fuel technology, and sodium technology and engineering. A record of the presentation and discussion of the papers is included. Separate abstracts were prepared for 35 of the papers. Abstracts have been previously included in NSA for two papers and parts of two others, and can be found under CONF-660502 in the Report Number Index. (UK)

For abstracts of individual papers see: 17077, 17189, 18502–18529, 18569–18571, 18600, and 18601.

18502 FAST REACTOR DEVELOPMENT IN THE UNITED STATES. Whitman, M. J. (Atomic Energy Commission, Washington, D. C.); Fortescue, Peter; Hannum, W. H.; Leitz, F. J. Jr.; Trauger, D. B. pp 275-89 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The advanced fast reactor programme is surveyed. The programme for the Na-cooled fast ceramic reactor is devoted mainly to studies of fuel technology, reactor physics, core engineering, and Na mass transfer, and the design and operation of the SEFOR experimental reactor test. Work on gas-cooled fast reactors is continuing, with fuel irradiations and design studies; the future potential of the system is discussed. A review of the Los Alamos molten Pu programme was abstracted previously (NSA 20: 32798). (UK)

18503 ENGINEERING COMPONENTS FOR A SODIUM COOLED FAST POWER REACTOR. Vautrey, L. (CEN, Fontenay-aux-Roses, France); Robin, M. G.; Leduc, J.; Zaleski, C. P.; Lions, N. pp 897-913 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The present state of the engineering studies carried out in France on sodium-cooled fast power reactors is described. An attempt is made to assess the advantages and disadvantages of the various systems under consideration. A discussion of components is based on a preliminary study of the most promising systems. In certain cases the further studies to be carried out, and the tests in progress or planned, are indicated. The components investigated are: vessel and Na supply system and fuel assembly supports, primary fuel handling system and top closure on vessel, control and safety rod mechanism, neutron shielding, primary circuits, pumps, intermediate exchangers, steam generators, and purification systems. (auth)

18504 UNITED STATES SODIUM COMPONENTS PROGRAMME. Morabito, J. J. (Atomic Energy Commission, Washington, D. C.); Jones, R. H.; Dickinson, R. W.; Savage, H. W. pp 851-72 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The experience and current status of the Sodium Components Development Programme are discussed. Some of the significant results of the evaluation of the operation of Hallam and SRE components since April 1965 are reported. Component development programmes summarised relate to steam generators, sodium-water reactions, tube thinning in the failure of steam generators, and the design of pumps, valves, seals, and bearings. Other programmes reviewed include mass transfer studies and the related effects on the properties of materials, analytical methods for Na, and the development of an ultrasonic under-sodium scanner. (UK)

18505 PROBLEMS IN THE SELECTION AND UTILIZATION OF MATERIALS IN SODIUM COOLED FAST REACTORS. Nettley, P. T. (United Kingdom Atomic Energy Authority, Culcheth, Eng.); Bell, I. P.; Thorley, A. W.; Tyzack, C.; Bagley, K. Q.; Harries, D. R. pp 825-49 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Work to determine the behaviour of circuit, control, and fuel element cladding materials for the PFR is described. Work on Na chemistry was concentrated on the study of mass transfer of metal due to solution or oxidation processes, and of carbon in circuits which contain both ferritic and stainless steels. The effects of Na temperature, velocity, and O_2 concentration were fully investigated. Work is described on the creep properties of type 316 stainless steels. Data are included on Ni alloys and other alternative cladding materials. The effects of grain size, and of the degree of cold work are considered and the present state of knowledge of the in-pile behaviour of materials is reviewed. (UK)

18506 SODIUM TECHNOLOGY AND EQUIPMENT OF THE BN-350 INSTALLATION. Leipunskii, A. I.; Pinkhasik, M. S.; Bogdasarov, Yu. E. pp 797-808 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

An outline is given of the Na circulating pumps, intermediate heat exchangers, and steam generators, and of the supporting experimental programme. Other Na technology problems discussed include the design of shut-off valves, cold traps, and drain tanks. (UK)

18507 CONTROL AND INSTRUMENTATION OF THE PROTOTYPE FAST REACTOR. Evans, P. B. F. (United Kingdom Atomic Energy Authority, Risley, Eng.); Burton, E. J.; Duncombe, E.; Harrison, D.; McAffer, N. T. C.; Jackson, G. O. pp 765-82 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

An outline is presented of the automatic control system and the associated flux and temperature monitoring system. The detection of fault conditions and the overall stability are discussed. Sodium instruments described are a transit time primary circuit flowmeter, electromagnetic secondary circuit flowmeters, flow failure monitor, differential transformer type level monitors, and an experimental continuous automatic plugging meter. The system for handling and presentation of data from 2500 measuring points incorporates computer based data reduction equipment and cathode ray tube displays. (UK)

18508 CALCULATION OF LARGE FAST REACTORS. Braess, D.; Froelich, R.; Jansen, A.; Kuesters, H.; Schroeter, K. E. (Kernforschungszentrum, Karlsruhe, Ger.). pp 747-63 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Problems of the preparation and use of cross-sections and group constants are discussed. Consideration of the procedures used for neutronic calculations include a comparison of one- and two-dimensional methods for a cylindrical reactor, and the use of different numbers of condensed groups. The methods of calculation of reactivity changes due to loss of coolant and Doppler effect are described. Discussion of core disassembly and second criticality is restricted to the energy release calculated according to the reactivity input using a modified Bethe–Tait model. Problems of fuel burn-up and fuel management are treated from the point of view of short term fuel cycles involving Δk_{eff}, power distribution, utilization of fuel, etc., and the long term effects of recycling. (UK)

18509 SOME PHYSICS STUDIES IN SUPPORT OF PFR DESIGN. Smith, D. C. G. (Atomic Energy Establishment, Winfrith, Eng.); Wheeler, R. C.; Mann, J. E. pp 711-27 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Problems considered include the choice of nuclear data and calculation methods, critical enrichment, control rod worths, radial blanket design, spatial distribution of reaction rates, the Doppler and Na coefficients, and the effect of burnup on these. The PFR kinetics are examined against the background of experience of DFR operation. Aspects considered are the isothermal temperature coefficients and power coefficients, slow response feedback and steady state measurements, problems of measurement of kinetic behaviour, and fault studies. (UK)

18510 PHYSICS, KINETICS, AND SHIELDING OF FAST BREEDER REACTORS: SURVEY OF RECENT WORK DONE IN FRANCE. Storrer, F. (CEN, Cadarache, France); Chaumont, J. M.; Cadilhac, M. pp 685-710 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

An extension of the perturbation method for determining the influence of heterogeneity on Doppler and Na loss coefficients is presented. A description is also given of a new perturbation method which gives perturbed reaction rates by first calculating flux perturbations. Other work on reactor physics includes a simple model for the treatment of neutron slowing down, use of a modified diffusion coefficient to calculate control rod worth by an extension to multigroup of the one-velocity ABH method, development of a one-group one-dimensional analytical code for parametric studies and long term behaviour analysis, cross-section data studies, use of Monte Carlo methods for solving problems of complex geometries, and Doppler effect calculations. Difficulties encountered in the interpretation of multizone experiments are discussed. Theoretical work on analysis and interpretation of pulsed experiments is summarised. Stability was investigated using a point model for the neutronics and a spacial model for thermal feedback. The influence of Doppler coefficient and of the equation of state on accident evaluation is under investigation. Shielding studies included attenuation in materials and the propagation of neutrons in gaps and cavities. (UK)

18511 TECHNOLOGY OF SODIUM COOLED FAST REACTOR FUELS IN THE U.S. Simmons, J. M. (Atomic Energy Commission, Washington, D. C.); Moss, D. A.; Astley, E. R.; Evans, E. A.; Kittel, J. H.; Strasser, A. pp 615-30 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The fuel development programme has concentrated on mixed oxide, mixed carbide, and metal alloy fuels. Irradiations achieved in thermal reactor tests were 99,000 MWd/$t_{U,Pu}$ for the oxides, 114,000 MWd/t_{U+Pu} for the carbides, and about 80,000 MWd/t_{U+Pu} for the alloy fuels. Fuel fabrication processes which affect irradiation behavior are discussed. Progress in the study of stainless steels, Inconel 625, Incoloy 800, and Hastelloy-X as cladding materials is reported. A discussion of the Fast Flux Test Facility programme was abstracted previously (NSA 21: 15763). (UK)

18512 DESIGN AND DEVELOPMENT OF FUEL AND FUEL ELEMENTS FOR A PROTOTYPE FAST REACTOR. Bishop, J. F. W. (United Kingdom Atomic Energy Authority, Risley, Eng.); Boorman, C.; Jackson, G. O.; Linning, D. L.; Parkinson, N.; Williams, A. E. pp 575-95 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Mixed oxide and mixed carbide fuels are discussed in relation to the known data on gas release, swelling, etc. The physical properties of stainless steel and nickel base cladding alloys are summarised, and the effects of neutron exposure noted. The boundary conditions within which a successful fuel element design must be sought are delineated, and a set of design criteria are formulated and discussed. Details of the PFR fuel element and sub-assembly are indicated and the conceptual problems are summarised. These include fission product blacking, plutonium migration, pin-grid interaction, and coolant flow distribution. The manufacturing development undertaken on the cladding material, the fuel, and the pin and sub-assembly is reviewed. The results of the performance evaluation programme are given under the headings of design detail, fuel-cladding compatibility, coolant corrosion, sub-assembly flow testing, endurance loop testing, and irradiation programme. A critical review of the PFR fuel element design is presented. (auth)

18513 THEORETICAL AND EXPERIMENTAL WORK ON THE PHYSICS OF FAST REACTORS. Smith, R. D.; Baker, A. R.; Rowlands, J. L. (Atomic Energy Establishment, Winfrith, Eng.). pp 513-43 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The use of multi-group diffusion theory in one and two dimensions, multigroup S_n methods, and the GEM Monte Carlo code for the calculation of fast reactor behaviour are described. The group cross-section data in use are discussed. Results obtained from the calculation of reactivities and reaction rates are compared with measurements made on Zebra cores. The large discrepancies between control rod worth predictions and perturbation measurements are discussed. An assessment is made of calculations and measurements of the Na and Doppler temperature coefficients, and preliminary spectra measurements are reported. (UK)

18514 FAST BREEDER DOPPLER EFFECT INVESTIGATIONS IN ISRAEL. Yiftah, S. (Israel Atomic Energy Commission, Yavne. Technion-Israel Inst. of Tech., Haifa); Gitter, L.; Ilamed, Y.; Lemanska, M.; Rothenstein, W.; Shaviv, G.; Segev, M. pp 421-43 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The Doppler effect was calculated by three methods (developed and coded for the Philco-2000 computer), based on successive-k, perturbation, and Monte-Carlo techniques. The method adopted and the scope of the code are described for the Monte-Carlo technique. Nuclear data on resonance parameters are reviewed, and the values used are given. Systems studied included 800 to 2500 liter reactors fueled with Pu–U as metal, oxide, and carbide, with varying isotopic Pu content. Doppler calculations were made for the 1000 MW(e) Karlsruhe-specified system using a one-dimensional model. Results quoted for the successive-k method are compared with those by the perturbation method. Some statistical difficulties encountered in estimating the Doppler effect by the Monte-Carlo method are discussed in a supplement, which includes some amended values for preferred average neutron resonance parameters. The primary specific problems under investigation are listed. (UK)

18515 THE U.S. EXPERIMENTAL PROGRAMME FOR FAST REACTOR PHYSICS. Avery, R.; Dickerman, C. E.; Kato, W. Y.; Long, J. K.; Smith, A. B. (Argonne National Lab., Ill.). pp 403-20 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Progress in basic cross-section measurements in the resonance, intermediate, and continuum regions is described. Critical experiments discussed relate to Doppler effects, Na void effects, and zoned core studies. Other test programmes reviewed include the SEFOR project, and the out-of-pile and TREAT experiments related to safety. (UK)

18516 LARGE COMMERCIAL SODIUM COOLED FAST REACTORS. Tattersall, J. O. (Nuclear Power Group Ltd., Knutsford, Eng.); Bell, P. R. P.; Emerson, E. pp 351-72 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The size of unit, breeding ratio, and fuel inventory are discussed in relation to power programmes, quality of output heat, operational convenience and availability, safety, and economics. Against this background, the design of a large commercial sodium cooled fast reactor station is outlined. The design and performance of the overall plant and its major components are discussed to show how they will meet the requirements, and to show what alternatives may be available. The capital and generation costs which may be expected for a station of the design outlined are indicated, and a short review is given of development potential. It is further shown how the projected design and design alternatives will be substantiated in the research programme. (auth)

18517 1000 MW(e) SODIUM COOLED FAST BREEDER REACTOR STUDIES. Pursel, C. A.; Link, L. E. (Argonne National Lab., Ill.). pp 333-50 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Four 1000 MW(e) ceramic fuelled LMFBR design studies were published in 1964. The design and performance characteristics of these, and more recent studies, are summarised, and resulting research and development programmes are reviewed. Specific topics discussed include fuel cycle and power costs, fuel irradiation experience, accident analysis and reactor safety, and plant thermodynamics. (UK)

18518 DESIGN STUDIES OF FAST REACTORS IN FRANCE. Vautrey, L. (CEN, Fontenay-aux-Roses, France); Zaleski, C. P. pp 317-32 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Preliminary studies for a 1000 MW(e) design and for the prototype reactor "Phenix" are described. Optimum operating conditions for a can hot-spot temperature of 700°C and a core pressure drop of 6.5 bars were found to be as follows: primary Na 411 to 567°C, secondary Na 348 to 556°C, feedwater 289°C, and steam 540°C 163 bars. Designs for the reactor and primary circuit considered range from the integral circuit to that with external circuits and external shielding. The designs are discussed from the points of view of safety and reliability, materials, equipment support, number and arrangement of pumps and exchangers, and neutron shielding. The problems of control rod mechanisms and fuel handling are examined. (UK)

18519 DESIGN OF THE PROTOTYPE FAST REACTOR. Frame, A. G.; Hutchinson, W. G.; Laithwaite, J. M.; Parker, H. F. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 291-315 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

A description is given of the design of the plant, and the design philosophy is outlined. The 250 MW(e) reactor is cooled by 3 primary and 3 secondary Na loops. A coolant outlet temperature of 560°C is envisaged, giving steam conditions at the turbine of 513°C and 2300 psi with a single stage reheat. The design description gives details of the core, control rods, coolant circuits, steam turbine plant, fuel handling, building layout, safety considerations, and experimental facilities. (UK)

18520 THE BN-350 AND BOR FAST REACTORS. Leipunskii, A. I.; Afrikantov, I. I.; Stekol'nikov, V. V.; (and others). pp 243-74 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The BN-350 reactor, in course of construction, is designed to produce 150 MW(e) and 12,000 t/d fresh water. The refuelling system is described and progress with the testing programme is reported. The safety, regulation, and control system is outlined. The prevention of undue thermal stresses and the effect of Na flow on the reactivity are discussed in relation to emergency shutdown cooling and transient conditions. The 60 MW BOR experimental fast reactor is described. A summary is given of the experimental facilities. (UK)

18521 RECENT OPERATING EXPERIENCE AT THE ENRICO FERMI ATOMIC POWER PLANT. McCarthy, W. J. (Power Reactor Development Co., Detroit); Olson, W. R.; Alexanderson, E. L.; Branyan, C. E. pp 187-211 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

A survey is presented of the operating experience at the plant during the power escalation programme. As of May 1, 1966, the maximum power level reached was 67 MW(t). Results are reported of measurements of transfer function, power coefficients, system characteristics during transients, and thermal performance. Steam generator design and operation are outlined, and an account is given of the problems encountered in stopping small leaks from the water to the Na side. Other components and systems for which the behaviour is reported include fuel, control rods, neutron source, fuel handling, reactor control system, primary Na system, and containment. (UK)

18522 A REVIEW OF THE OPERATION OF THE DOUNREAY FAST REACTOR. Henry, K. J.; Edwards, A. G. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 153-69 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Several years operation of DFR as a fast flux irradiation facility, with a load factor exceeding 60% and by-product electricity generation of 15 MW, is reviewed. The performance of the metal fuel up to 3.4% burn-up was excellent. Reactor improvements included changes to the inner breeder to increase reactivity and enhance local fissile material ratings. Unexpected uranium swelling in the outer breeder led to modifications. Control rod arrangements were improved, in the light of operating experience, as also were techniques for stability monitoring. Some new instrumentation is described. There was a steady improvement in coolant purity, and Nb-cladding corrosion was no longer a problem. The disadvantages of the use of vented fuel were outweighed by the improvement of the thermal bond between fuel and can. The measurement and calculation of neutron flux, gamma flux, and temperature are described. The three basic types of irradiation experiment appropriate to DFR are outlined. Possible future improvements and future use of the facility are briefly considered. (auth)

18523 EBR-II INITIAL OPERATION: HIGHLIGHTS. Monson, H. O. (Argonne National Lab., Ill.). pp 135-52 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Some of the highlights of the transition from preoperational testing to operation of the facility are described, and the operating experience is summarized. Events during the approach to power are outlined. Selected aspects of operation which are detailed include reactor and primary system performance, secondary and steam systems, fuel handling, physics, instrumentation, pump performance, coolant purity, fuel element rupture detection, and operation of the fuel cycle facility. Only minor troubles have arisen. A number of problems were encountered during fuel handling, and there were some difficulties with the steam systems and pumps. Performance of the Mk. II fuel element was extremely good up to the maximum of 1.25 at. % burn-up. Irradiations in the core and blanket are tabulated. Modifications are in progress to enable EBR-II to be used primarily as a fast flux irradiation test facility. (UK)

18524 PRESENT AND FUTURE TYPES OF FAST BREEDER REACTORS. Moore, R. V. (United Kingdom Atomic Energy Authority, Risley, Eng.); Fawcett, S. pp 99-112 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Some future developments envisaged for the Na-cooled fast reactor are indicated under the headings of reactor size, fuels, materials, and design. Reference is made to previous studies employing other liquid metals as coolants, particularly Pb and Bi. Other designs discussed are gas cooled, steam cooled, and fluid fuelled fast reactors. (UK)

18525 DESIGN AND EVALUATION OF A STEAM COOLED FAST BREEDER REACTOR OF 1000 MW(e). Mueller, R. A.; Hofmann, F.; Kiefhaber, E.; Smidt, D. (Kernforschungszentrum, Karlsruhe, Ger.). pp 79-97 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

An outline description of the reference design is presented. The basic decisions which are discussed include the choice of Inconel 625 clad UO_2/PuO_2 fuel, steam outlet conditions of 170 at. % and 540°C, and a direct cycle Loeffler coolant system with spray type steam generators. General features of the design which are considered include the breeding ratio, rod power and rating, and the reactivity coefficient of coolant density. Preliminary results are given of economic and optimization studies. (UK)

18526 THE PLACE OF THE FAST BREEDER REACTOR IN THE REACTOR DEVELOPMENT PROGRAMME IN JAPAN. Murata, H. (Atomic Energy Commission, Tokyo). pp 67-77 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The significance of Japan's nuclear power generation programme and her need for the fast breeder reactor is indicated. An account is given of plans for research and development of the fast reactor. (UK)

18527 FAST BREEDER REACTOR PROGRAMME IN THE UNITED STATES. Shaw, Milton (Atomic Energy Commission, Washington, D. C.). pp 35-65 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The fast breeder programme, which concentrates on the LMFBR design, is discussed in relation to the overall US power reactor development. A survey is presented of the status of the programme on the basis of the formal intensive and comprehensive reviews made in each technical area. Reviews have been completed on fuel and materials, and physics, and are continuing in the fields of fuel reprocessing and recycling, safety, components, instrumentation and control, Na technology, fuel handling, and plant design. The availability of the related facilities is being considered in each case, and the significant lack of irradiation test space is emphasised. The problems requiring solution before a 300 to 500 MW(e) demonstration plant can be built are examined. Work on alternative coolants is briefly summarised. (UK)

18528 THE PLACE OF FAST REACTORS IN THE FRENCH NUCLEAR PROGRAMME. Vendryes, G. (CEN, Saclay, France); Cordelle, F.; Denielou, G.; Rozenholc, M.; Sebilleau, F.; Thibierge, M.; Zaleski, C. P.; Vautrey, L. pp 31-4 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Construction of the first 1000 MW(e) fast reactor station is envisaged between 1975 and 1980. A 250 MW(e) prototype, "Phenix," is being studied. This should be started in 1969 and come on power in 1976. The prototype design is discussed, and the main parameters are listed. (UK)

18529 A REVIEW OF FAST REACTOR DEVELOPMENT IN THE EURATOM COMMUNITY. De Stordeur, A. pp 21-9 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The research programmes of France, Germany, Italy, Belgium, and Holland, in association with Euratom, have as their overall object the achievement of competitive fast breeder reactor power by the late 1970's. Construction of prototype reactors in the range 100 to 300 MW(e) could be envisaged to start in 1969. Work is surveyed in the fields of large reactor and core design, physics and safety, reactor system development, and fuel preparation and processing. (UK)

18530 IMPROVEMENTS IN OR RELATING TO LIQUID MODERATED NUCLEAR REACTORS. Deighton, Thomas (to Babcock and Wilcox Ltd.). British Patent 1,098,623. Jan. 10, 1968. Filed June 28, 1963.

A method is described for operating a liquid-moderated reactor, particularly a water moderated reactor, which includes a core and moderator material and made up of fissile material having the moderating liquid at a pressure which is close to but below the thermodynamic critical pressure of the liquid. In this pressure range the rate of change of saturated liquid density with pressure is relatively high. The reactor is operated under simmering conditions. The core is under moderated, and the reactor is critical when the pressure of the moderator has a value within a specified range (2800 to 3200 psi for water moderator). When fissile material has been consumed in the reactor operation with a reduction of pressure to another value within the range, the increase of the average moderating liquid density in the core increases the neutron slowing down power of the liquid so that the fissile material in the core is still sufficient to provide reactor criticality. The reactivity of the core is controlled by burnable or soluble poisons which are removed as fissile material is consumed. (B.L.M.)

18531 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock and Wilcox Co.). British Patent 1,091,918. Nov. 22, 1967. Priority date Nov. 15, 1963, United States.

A fast breeder reactor includes a core encircled by a breeder portion. The core portion includes material fissile under neutron irradiation to produce neutrons by which fertile material in the breeder portion is transformed into fissile material. The reactor is arranged to operate with moderating fluid flowing as coolant upwardly through the breeder portion of the reactor and downwardly through the encircled core portion. During operation, this coolant stream is made up preferably of two portions, part that has flowed upwardly through the breeder portion and part that has bypassed the breeder portion. (B.L.M.)

18532 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Halliday, Dixon Brydson (to United Kingdom Atomic Energy Authority). British Patent 1,095,149. Dec. 13, 1967. Filed Aug. 28, 1964.

A reactor in which water is used as a moderator, coolant, and reflector comprises a vessel ring-shaped in horizontal cross section to contain the water reflector, vent means associated with the vessel to maintain the interior of the vessel at atmospheric pressure, a number of elongated tubular fuel elements located within the central void of the vessel to form the core, and means for passing a coolant fluid through the core to act as coolant and moderator. The fuel elements are a highly enriched U alloy fuel and are so spaced as to provide a severely under-moderated core. (B.L.M.)

18533 FAST NUCLEAR REACTOR. Ackroyd, Ronald Tunstall; Lord, Reginald Martin; Mann, John Erskine (to United Kingdom Atomic Energy Authority). British Patent 1,091,203. Nov. 15, 1967. Filed Sept. 26, 1963.

A heterogeneous fast nuclear reactor designed to be cooled by Na or a low melting point Na-base alloy is described. The reactor has a substantially cylindrically-shaped fast fuel region bounded by regions having a greater proportion of fertile to fast material than the fast fuel region. These bounding regions are cooled by the flowing coolant. A zone which provides a passage for coolant during normal operation of the reactor is adjacent to the boundary between the bounding regions and is coextensive with at least one of the faces of the fast fuel region. This zone has a coolant volume fraction approximately unity and greater than either of the previously mentioned regions and has a thickness exceeding the neutron mean path in the coolant for the neutron energy spectrum prevailing in the fast fuel region during normal operation of the reactor. (B.L.M.)

18534 METHOD FOR CONTROLLING A NUCLEAR REACTOR. Horibe, Osamu (to Kawasaki Dockyard Co., Ltd.). Japanese Patent 1967-7752. Mar. 29, 1967. Filed June 19, 1964.

The method proposed is used for a heavy-water moderated reactor. The advantages of the method are: a flattening of a neutron-flux distribution; elimination of a shim control rod; an increased neutron economy; and the stable reactor control. It consists of an inner heavy-water tank, and an outer heavy-water tank (which surrounds the inner one). Both the inner and the outer tank are divided in the vertical direction into a plurality of sections; and the heavy-water level in each section can be adjusted independently of other sections. (NSA of Japan)

18535 METHOD FOR CONTROLLING THE OUTPUT OF A NUCLEAR REACTOR. Hayashi, Tsutomu (to Hitachi Ltd.). Japanese Patent 1967-12015. July 8, 1967. Filed July 7, 1965.

The output of the boiling water reactor can be controlled in accordance with the variation in load of the turbine system without moving the reactor control rods over a fairly large range of load variations. Part of the feed (or recirculating) water from the turbine is evaporated by means of part of the superheated steam from the superheating reactor. The amount of vapor produced, which is fed into the boiling-water reactor for control purposes, is changed according as the load of the turbine system is varied. (NSA of Japan)

18536 METHOD FOR CONTROLLING THE OUTPUT OF A NUCLEAR REACTOR. Oki, Shinhiko (to Hitachi Ltd.). Japanese Patent 1967-12014. July 8, 1967. Filed July 7, 1965.

The method proposed is applicable for the type of reactor in which the (nuclear) steam-superheating is incorporated in the reactor itself. The output of the reactor can be changed in accordance with rapid variations in load of the turbine system without using the control rods. High-pressure steam is produced by heating (pressurized) part of the feed (or recirculating) water from the turbine with part of the superheated steam to the turbine. This steam is fed into the boiling reactor-core and its amount is changed according as the turbine load is varied for the purpose of reactor control. (NSA of Japan)

18537 NUCLEAR REACTOR. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1967-12013. July 8, 1967. Filed July 7, 1965.

In the (boiling-water) nuclear reactor proposed, reactor-control poison solution is introduced into the reactor core, separated from the coolant water. The advantages obtainable are increase of the fuel burn-up, increase of the operation efficiency, simplification of the reactor construction, and improvement in the reactor safety. The boiling reactor core is divided into a few concentric regions, by the use of partitioning walls. Poison solution, separated from the coolant water, enters first the central region, runs through the successively outward regions, and finally leaves the reactor core through the outmost region. (NSA of Japan)

18538 NUCLEAR REACTOR POWER PLANT ARRANGEMENT. Schluderberg, Donald Carroll (to Babcock and Wilcox Co.). U. S. Patent 3,364,121. Filed Apr. 20, 1965.

A nuclear reactor system comprising a nuclear reactor, a turbine exterior of the reactor, and a mixing T is described. The reactor has two coolant flow zones with the first zone maintaining a constant radial power level and the second zone having a large power gradient. The coolant in the first zone is heated to a temperature higher than the coolant in the second zone, and it is then pumped to the turbine inlet. The coolant in the second zone is pumped to the inlet of the mixing T. The turbine outlet also connects to the mixing T inlet. The mixing T connects to the reactor inlet. (U. S. Pat. Gazette)

18539 ZONED FUEL FAST REACTORS. Nims, John B.; Page, Earl M. (to Atomic Power Development Associates, Inc.). U. S. Patent 3,364,119. Filed Oct. 24, 1965.

The description of a zoned fuel liquid sodium-cooled fast nuclear reactor is presented. The core consists of a medial region and an outer region. The medial region is comprised of spaced ^{233}U and ^{232}Th fuel elements for reducing the sensitivity of the reactivity to the loss of Na-coolant. The outer region has a plurality of ^{239}Pu and ^{238}U fuel elements. The middle regions comprise about 25% of the volume of the core. (U. S. Pat. Gazette)

Marine and Portable Power Reactors

18540 COMPETITIVE NUCLEAR-POWERED MERCHANTMAN. Teasdale, J. A. Shipping World Shipbuilder, 160: 1179; 1181; 1183(July 20, 1967).

A 24,000 ton vessel design is proposed having separate motive and cargo units. The motive unit, operable as an independent vessel with water ballast, has a 'V' shaped bow which interlocks in the tail of the cargo unit. Mechanical connections are only required at the deck level. Problems of the design are considered. A comparison of the operational characteristics shows the transportation capacity of the design to be equivalent to that of 2.43 conventional integral ships. (UK)

Rocket and Space Reactors

18541 (GA-8244) OPTICAL CONSTANTS OF URANIUM PLASMA. Final Report. Parks, D. E.; Lane, G.; Stewart, J. C.; Peyton, S. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 2, 1968. Contract NAS 3-7961. 272p. (NASA-CR-72348). CFSTI.

Thermodynamic and optical properties of a uranium plasma are calculated for conditions that obtain in proposed gaseous-core nuclear rockets. As a quantitative basis for calculations, one begins with the relativistic wave-mechanical description of a single electron moving in a spherically symmetric potential. The potential is a modified Thomas-Fermi potential containing an arbitrary parameter whose value was determined by calibration against one-electron binding energies previously calculated by a relativistic, self-consistent-field method. From the corresponding single-particle wave functions, oscillator strengths and many-electron properties of ions that are relevant to thermodynamic and optical properties are determined. Particular emphasis is given to the often significant effects associated with the rich energy level and line spectra that appear in the spectroscopy of ions having several electrons in partially filled shells. Pressure ionization is treated in a manner that is approximately valid for nondegenerate gases for any ratio of Debye length to ion sphere radius and that satisfies the requirements of thermodynamic consistency. Specific results for composition, thermodynamic functions, and local and overall Planck and Rosseland mean opacities of uranium are given for the temperature range from 5000°K to 110,000°K and the pressure range from 100 to 1000 atmospheres. Finally, the theoretical opacity at 5100°K and 3.58×10^{-4} atm is compared with that inferred from the measured emission from an arc containing uranium. (auth)

18542 (HW-84412) SHUTDOWN CHARACTERISTICS OF ^{233}U, ^{235}U, AND ^{239}Pu PROPULSION REACTORS. Little, W. W. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 7, 1964. Contract AT(45-1)-1350. 12p. Dep. CFSTI.

The comparison of shutdown rates for ^{239}Pu, ^{233}U, and ^{235}U reactors for specified reactivity variations is presented. All kinetics calculations are performed using a lumped parameter neutronics model with six groups of delayed neutrons. Only short term shutdown is considered ($0 \leq t \leq 60$ sec), therefore the effect of fission product heating is neglected. Results show that ^{239}Pu reactors appear to require significantly less propellant for after-cooling than ^{235}U reactors. (auth)

18543 (NAA-SR-Memo-11131) RESULTS OF S8ER SAMPLING PROGRAM. Rosen, S. L. (Atomics International, Canoga Park, Calif.). Jan. 14, 1966. 43p. Dep. CFSTI.

An extensive sampling program was conducted throughout the period of operation of the S8ER. More than 100 chemical analyses of primary and secondary NaK, containment vessel atmosphere Be contamination, primary system He cover gas trace gaseous fission products, and facility water cooling activation and corrosion parameters were conducted and reported by supporting groups. Thousands of in-plant containment vessel atmosphere and primary vault atmosphere impurity control samples were obtained and analyzed by the operating crews. Data obtained from the samples has been reported regularly during the experimental program in the form of interim reports. Five such interim reports have been published and they are updated and summarized herein. In addition, the Procedure and Results and Conclusions of Test 8ER-035 Addendum I, "Radioactive Primary System NaK Sampling Procedure", are included. (auth)

Process Heat and Desalination Reactors

Refer also to abstract 17146.

18544 (STI/DOC-10/80) GUIDE TO THE COSTING OF WATER FROM NUCLEAR DESALINATION PLANTS. Technical Reports Series No. 80. (International Atomic Energy Agency, Vienna (Austria)). 1967. 84p. Dep. IAEA: \$2.00; Austrian Schillings 52,-; 14/2 stg; F Fr 9.80; DM 8,-.

A report commissioned by the IAEA and prepared by Applied Research and Engineering Limited (AERL) is presented. With the data presented, a relatively detailed study on the costing of water from nuclear desalination plants is described. Topics discussed include: cost of steam from nuclear reactors; cost of steam from fossil-fuelled boilers; power-plant considerations; desalination equipment; and use of data to establish costs. Sample calculation of steam cost from reactors, and a digital computer programme for the simplified thermodynamical analysis (with detailed costing) of a multi-stage flash evaporator are presented. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 16738, 16922, 16940, 17154, 18520, and 18587.

18545 (BNWL-622) PCTR MEASUREMENT OF k_∞ FOR URANIUM LITHIUM SUPERCELL. Newman, D. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 20, 1967. Contract AT(45-1)-1830. 70p. Dep. CFSTI.

Experimental values for infinite medium neutron multiplication factor, k_∞, have been determined for a graphite moderated supercell utilizing 2.1% enriched U fuel and 2.93 wt % Li-in-Al target in separate process tubes, in a three-to-one ratio. Determinations of k_∞ were made with the coolant channels wet and dry to obtain an estimate of the reactivity coefficients due to water loss. Both a 6 × 6 and 5 × 5 array of test cells were inserted in the PCTR test cavity for these measurements. Results of experimental measurements are listed. (auth)

18546 (CEA-R-3336) MESURES DE REPONSE IMPULSIONNELLE D'UN REACTEUR TRES SOUS-CRITIQUE (AQUILON, NOVEMBRE 1965). (Measurements of the Pulse Response of a Very Subcritical Reactor (Aquilon, November 1965). Cazemajou, Jean; Beliard, Lucien (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 44p. (In French). Dep.

The results of a series of experiments carried out on AQUILON in November 1965 by the pulsed neutron method are presented. Experimental constants for a very sub-critical medium, as little heterogeneous as possible, were obtained. The effect of the reflector had been eliminated by surrounding the core with a Cd skirt; the change in antireactivity was obtained as a result of modifying the Laplacian by changing the level of the moderator. About twenty measurements were effected between the critical level and the zero level. The use of a fast channel made it possible to obtain precise results in a relatively short time. (auth)

18547 (DOCKET-50231-1) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 6, Suppl. 1. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Dec. 7, 1967. 57p. Dep. CFSTI.

Supplementary information on analysis of SEFOR mockup critical experiments in ZPR-3 is given. Information includes: ratio of prompt neutron lifetime to effective delayed neutron fractions, reaction ratios, reaction-rate traverses, ^{239}Pu traverses, and an evaluation of reflector leakage probabilities. 24 references. (M.L.S.)

18548 (DOCKET-50231-2) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 6, Suppl. 2. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Dec. 5, 1967. 49p. Dep. CFSTI.

The specifications for the SEFOR reactor safety system, the nuclear instrumentation and reflector drive control system are given; elementary engineering drawings are included. (M.L.S.)

18549 (DOCKET-50231-3) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 7, Suppl. 3. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Dec. 27, 1967. 80p. Dep. CFSTI.

Results of radiation testing of SEFOR fuel and clad materials are given. Radiation conditions are delineated; capsule and fuel specimen designs are presented. The fourteen individual tests are described; results are shown graphically. The results are, then, discussed. Diametral measurements for the specimens are tabulated; photographs of the fuel sections are included. (M.L.S.)

18550 (DOCKET-50231-4) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 7, Suppl. 4. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Dec. 27, 1967. 80p. Dep. CFSTI.

Measurements of fluid flow and vibration characteristics of the SEFOR reactor vessel are detailed. Results are presented in graphic and tabular form. The test operation and assembly are described. (M.L.S.)

18551 (DOCKET-50231-5) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 8, Suppl. 5. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Jan. 18, 1968. 64p. Dep. CFSTI.

Specifications for SEFOR Core I fuel pellets are given. This includes requirements for uranyl nitrate, plutonium nitrate, UO_2 insulator pellets, and fuel rods. The quality control plan for fuel pellets and rods is described; the inspection plan is outlined. (M.L.S.)

18552 (DOCKET-50290-1) PROOF TEST FACILITY (PTF). [Preliminary] Safety Analysis Report. Brooks, W.; Krumbein, A. D. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Apr. 28, 1967. 102p. (UNC-5175). Dep. CFSTI.

Information is included under the following main subjects: General Facility Description; Critical Assembly Components; Operations; Safety Analysis including nuclear characteristics of the system, radiation levels, fuel element failure, potential reactivity insertion accidents, and the nuclear incident; Calculation Techniques; and Technical Specifications for the Proof Test Facility. (M.L.S.)

18553 (DOCKET-50290-2) [PROOF TEST FACILITY (PTF)]. [Preliminary Safety Analysis Report], Amendment 1. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). June 9, 1967. 15p. Dep. CFSTI.

Supplementary information on the scram circuits, safety rods, rod drives and electromagnets is given; engineering drawings are included. Support structures for the reactor tank are described; storage of fuel assemblies is discussed in some detail. Ion chamber positioning and support structures are described. Fiscal balance sheets for United Nuclear Corporation, owner of the Proof Test Facility, are given. (M.L.S.)

18554 (DOCKET-50290-3) [PROOF TEST FACILITY (PTF)]. [Preliminary Safety Analysis Report], Amendment 2. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Oct. 30, 1967. 3p. Dep. CFSTI.

Modifications to the technical specifications for the Proof Test Facility are given. These pertain to operations procedures and the scram circuit. (M.L.S.)

18555 (GA-7485) EXPERIMENTAL BERYLLIUM OXIDE REACTOR PROGRAM. Quarterly Progress Report, September 30, 1966–December 31, 1966. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Feb. 8, 1967. Contract AT(04-3)-187. 47p. Dep. CFSTI.

BERYLLIUM OXIDE REACTOR EXPERIMENT—operation description during September to December 1966, description of; cooling system for, description of
REACTOR FUEL ELEMENTS—description of EBOR
REACTOR CONTROL ELEMENTS—drive mechanism for EBOR, description of
BERYLLIUM OXIDE REACTOR EXPERIMENT—control rods for, description of program for straightening; physics calculations for, description of
REACTOR SAFETY—leak hazard in EBOR, analysis of main loop oil
CRITICALITY STUDIES—physics calculations for EBOR, description of
BERYLLIUM OXIDE REACTOR EXPERIMENT—maintenance description during September to December 1966
REMOTE-HANDLING EQUIPMENT—description of EBOR
LUBRICANTS—leaks of EBOR main loop oil, analysis of hazards of (D.C.C.)

18556 (GA-7802) ESCAPE OF LUBRICATING OIL INTO THE EBOR PRIMARY SYSTEM AND SUBSEQUENT CLEANUP. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Jan. 10, 1967. Contract AT(04-3)-187. 55p. Dep. CFSTI.

Findings of an investigation of the infiltration of main He-blower lubricating oil into the primary loop of the EBOR on February 21, 1966 during valve testing operations and cleanup actions are presented. A description of the accident, a discussion of its possible causes, a review of the steps taken to empty and clean the loop, and an assessment of the damage to the plant are also presented. (auth)

18557 (GA-8087) FEASIBILITY STUDY OF AN ACCELERATOR-BOOSTER, FAST, PULSED RESEARCH REACTOR. NEUTRON YIELD STUDIES. Final Report. Groce, D. E. (Gulf General Atomic, Inc., San Diego, Calif.). June 30, 1967. Contract AT(04-3)-167. 60p. Dep. CFSTI.

The total yield of neutrons in accelerator-booster targets by high-energy electron bombardment is investigated as part of the feasibility of the use of an electron accelerator as a neutron source for a fast pulsed research reactor. Measurements of absolute neutron yields for ^{233}U, ^{235}U, ^{238}U, and ^{239}Pu targets of various thicknesses at several electron energies between 10 and 80 MeV are presented. (H.D.R.)

18558 (NAA-SR-Memo-12586) A DESIGN STUDY FOR FAST FLUX TEST FACILITY SECONDARY GAMMA SHIELD. Facha, J. V.; Roberts, J. G. (Atomics International, Canoga Park, Calif.). Dec. 20, 1967. Contract AT(04-3)-701. 107p. Dep. CFSTI.

Fuel handling and radioactive maintenance modes which involve occupancy of the reactor hot cell by the operating personnel utilize a secondary gamma shield over the reactor. The requirements are defined and the feasibility of such a shield is established for the FFTF reactor. Alternate rotating and stationary design concepts are presented and evaluated. (auth)

18559 (ORNL-TM-1924) LOW-INTENSITY TESTING REACTOR: SAFETY ANALYSIS. Binford, F. T.; Webster, C. C. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 79p. Dep. CFSTI.

The environmental consequences of an accident in operation of the LITR at 3 MW are examined. The radiation doses from fission product gases released through the stack and from radioactive material in the building following a 1 kW accidental release are plotted and evaluated. Credible accidents involving the core and not involving the core are discussed, and the radiation hazard consequences of the maximum hypothetical accident are analyzed. A history of operating difficulties for the LITR from 1958 are presented. It is concluded that operation of the reactor at 3 MW provides a large margin of safety. (H.D.R.)

18560 (WAPD-Trans-85) PROBLEMS IN CRITICAL CALCULATIONS FOR SMALL REACTORS (Analysis of the JRR-4). Nakamura, Shoichiro; Morita, Takahiro. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from Hitachi Hyoron, 48: 27-32(1966). 28p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

Critical calculations for nuclear reactors generally require high precision. On the other hand, the methods of calculation include many assumptions, and large errors can result from the choice and application of these assumptions. Some of the major problems in small reactors are the errors that can result from how the leakage in the vertical direction is treated, how the gross constants of fast neutrons are treated, and the construction of the core elements. These problems are examined using measurements made with the swimming pool reactor of the Japan Atomic Energy Research Institute (JRR-4) and the limits of error are determined. It has been shown that the critical conditions of small reactors of this type can be calculated with a high degree of precision using the results of these critical calculations. (auth)

18561 CONTAINMENT DESIGN AND STUDY FOR THE FAST CRITICAL ASSEMBLY OF JAERI. Uchida, T.; Iso, Y. (Japan Atomic Energy Research Inst., Tokyo). pp 473-86 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

The Fast Critical Assembly of the Japan Atomic Energy Research Institute (FCA) at the Tokai site is used to obtain the reactor physics data as the first step of the fast breeder reactor development schedule in Japan. The containment of FCA must meet the Japanese site criteria for the hypothetical accident, which is assumed as the gross-meltdown and resulting critical power excursion. A nuclear energy of 10^{20} fissions and a chemical energy of 3×10^7 cal resulting from the rapid metal-air reaction are estimated to be released at the hypothetical accident. The FCA containment consists of the primary containment to absorb the explosive energy equivalent to a TNT 100-kg explosion, and the secondary containment which withstands the internal static pressure of 1.6 kg/cm^2 and is gastight. It is also equipped with the argon ejection system to extinguish the metal fire within the containment area at the accident. The primary containment is a reinforced concrete structure of which the strain energy is designed to be more than the impulsive energy caused by a TNT 100-kg explosion. Tests were performed with scaled models to obtain the data on the dynamic pressure and impulse distribution and the response of structures due to the TNT explosion. A reinforced concrete cylinder with a hemispherical cap was selected as the secondary containment, and it was considered to be more advantageous than a steel vessel in economy shielding, and also anti-missile protection. The design philosophy of the FCA containment necessary to meet the given criteria and the data of the model for anti-blast design are given. 10 references. (auth)

18562 LEAKAGE RATE TESTS OF THE COMPARTMENTS OF THE KEMA SUSPENSION TEST REACTOR: COMPARISON OF VARIOUS METHODS (PRESSURE CHANGE AND OXYGEN IN-LEAKAGE). van der Lugt, G.; Kuypers, J.; Ruiter, J. P. (N. V. KEMA, Arnhem, Netherlands). pp 529-43 of Containment and Siting of Nuclear Power Plants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna. See STI/PUB-154; CONF-670402.

Leakage rate tests on the KEMA Suspension Test Reactor are described. Procedures are given; results of measurements are tabulated. All tests were performed by the absolute and reference vessel methods. (M.L.S.)

18563 FIRST EXPERIMENTS WITH THE ZERO POWER FACILITY ECO. Hage, W.; Hettinger, H.; Hohmann, H.; Metzdorf, H. J.; Toselli, F. Atomkernenergie, 13: 133-8(Mar.-Apr. 1968).

A short description is given of the zero power facility ECO, its reference fuel elements U/19/12, and a summary of the results obtained during the initial start-up experiments. Results of reactivity measurements on control elements and on certain perturbed core configurations are given, together with a list of the measured bucklings of the reference core. (auth)

18564 DETERMINATION OF A REFERENCE SPECTRUM IN THE INNER REFLECTOR OF THE ROSSENDORF ANNULAR CORE REACTOR (RRR) BY ACTIVATION FOILS. Albert, D.; Schumann, P. (Zentralinstitut fuer Kernforschung, Dresden). Kernenergie, 10: 306-8(Oct. 1967). (In German).

Integral spectrum measurements by activation foils in the center of the reactor RRR are described; absolute and relative techniques are used. In a polyethylene cylinder of 26 cm in diameter and 60 cm in height, inserted into the centre of the reactor, neutron spectrum parameters were determined. 10 references. (auth)

18565 THE EPITHERMAL NEUTRON CONVERTER OF THE B-2 BEAM OF THE BR-5 REACTOR. Lipunov, A. D.; Mashkovich, V. P.; Nikolaev, A. N.; Podsevalov, Yu. N.; Polivanskii, V. P.; Saharov, V. K.; Sinitsyn, B. I.; Suvorov, A. P.; Tsypin, S. G. At. Energ. (USSR), 23: 549-51(Dec. 1967). (In Russian).

The attenuation of epithermal neutrons in various shield assemblies was studied using a prism-shaped Fe converter in the B-2 beam hole of the BR-5 reactor. A disk-shaped, monodirectional, 30-cm diameter source with a beam divergence of ~5° was used. The ROZ program for 16 neutron energy groups was used to calculate the spectral and angular distribution of the scattered and nonscattered neutrons at the exit point. Analysis of the results revealed that for each fast neutron with $E > 1.4$ MeV, there are $\sim 5 \times 10^5$ neutrons with $E < 1.4$ MeV as 75% of the neutrons are concentrated in the energy range near the antiresonance in the cross section of Fe at $E \approx 25$ keV. The calculated distribution was experimentally confirmed by measurements with indicators based on the ^{63}Cu(n,γ)^{64}Cu reaction. It was found that for a shield thickness corresponding to an attenuation by a factor of $\sim 10^4$, the epithermal neutrons play the determining role. Two competing processes were observed near the interface of the converter and water: a fast attenuation to 100 keV and an intensive buildup of the thermal and slow neutrons. At higher thicknesses, the neutron spectrum becomes harder. (TTT)

18566 CONTROL AND FAST DATA RECORDING IN THE EXPERIMENTAL FACILITY CABRI. Delchambre, Ph. (CEA, Cadarache, France). Bull. Inform. Sci. Tech. (Paris), No. 120, 51-6(Nov. 1967). (In French).

CABRI is a light-water experimental swimming-pool reactor with an enriched uranium core. Located at the Cadarache C.E.A. establishment, the facility is designed for reactor safety studies and the study of behavior during transients: the nuclear, thermal, and mechanical effects of rapid parametric variations. Power experiments involve excursions of about 10^{10} W in a few tens of milliseconds. In view of the large number of measurements made during short time intervals and the need for complex, fast, and variable experimental sequences, a transient control and monitoring channel under the control of a CAE 330 computer was installed. The facility diverged in December 1963, and the first power step was made in April 1964. Since then the computer has satisfactorily piloted about 1000 experiments. (auth)

18567 SPECTRAL CORRECTION TO THE GARELIS–RUSSELL FORMULA. Aizawa, Otohiko; Yamamuro, Nobuhiro (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 4: 623-5 (Dec. 1967).

The reactivity of a subcritical assembly is frequently determined by injecting bursts of fast neutrons and measuring the decay curve of the neutron population. The Garelis–Russell formula for determining the reactivity utilizes the shape of the decay curve. To account for the spectral difference between the prompt and delayed fluxes as measured by a neutron detector not completely free of energy dependence, a correction factor to the formula is derived. In order to verify the correction factor, reactivity measurements were made with both bare and Cd-covered BF_3 counters. Comparison of the corrected and uncorrected results indicate a large correction factor is needed for the bare counter while the Cd-covered counter yields meaningful reactivities without correction. (H.D.R.)

18568 FABRICATION OF THE PLATE TYPE FUEL ELEMENTS. Yamamoto, Tatsuro (Furukawa Electric Co., Ltd., Tokyo). Fapig (Tokyo), No. 45, 42-46(June 1967). (In Japanese).

A description is made of the practices of fabrication, testing and inspection, and also of the pinning fabrication technique, developed and employed for MTR plate-type fuel elements. In this technique, holes are cut through the ends of the fuel plates and through the supporting side-plates, and pins are inserted through the holes to bring together the fuel plates and the side plates. (NSA of Japan)

18569 THEORETICAL AND EXPERIMENTAL WORKS ON FAST REACTOR PHYSICS IN JAPAN. Hirota, J. (Japan Atomic Energy Research Inst., Tokyo); Katsuragi, S.; Nozawa, M.; Nishihara, H. pp 729-45 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The survey covers various studies made on the derivation of group constants, and the use of the higher order perturbation method for the treatment of diffusion and transport equations. In studies of the nuclear characteristics of zoned systems, reactivity changes due to Na voids and Doppler effect were evaluated, and differences in large reactors were considered. The code TERESCOPE was developed for analysing the space-time behaviour before Na boiling, and methods of measuring various power coefficients were investigated. Experimental techniques are described, and some results are given for a series of neutron diffusion experiments for Pb and natural U. A horizontal splittable type critical facility for studies of large fast cores is under construction. (UK)

18570 EXPERIMENTAL AND THEORETICAL INVESTIGATIONS ON THE PHYSICS OF FAST REACTORS. Leipunskii, A. I.; Abagyan, L. P.; Bazazyants, N. O.; (and others). pp 445-91 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

A reactor of the BN-350 type was studied by the use of critical assemblies with two enrichment zones. Critical parameters were calculated and cross section ratios measured in the center of the assemblies. Perturbations caused by different materials, including ^{238}U, Ta, Re, Fe, Nb, Mo, and W, were investigated. Control rod effectiveness was studied and heterogeneity effects analyzed. Prompt neutron lifetime was measured by means of two enriched BF_3 proportional counters. Neutron propagation in UO_2 and the Doppler effect in ^{238}U were studied. Space-energy neutron distribution in the thick oxide blanket of the BR-1 reactor was measured. Some problems in calculation theory and methods are described, including theories of neutron propagation and transfer. (UK)

18571 EXPERIENCE GAINED FROM THE OPERATION OF THE BR-5 REACTOR, 1964-5. Leipunskii, A. I.; Orlov, V. V.; Pinkhasik, M. S.; Aristarkhov, N. N.; Karpov, A. V.; Efimov, I. A.; Ibragimov, Sh. Sh.; Ladygin, A. Ya.; Mamayev, L. I.; Krasnoyarov, N. V. pp 171-85 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

An outline is presented of the operation of the reactor from 1964 to 1965, during which period a mixed charge of PuO_2 and of UO_2 assemblies was replaced by UC fuel. PuO_2 elements achieved a maximum burnup of 6.5%, and the 90%-enriched UO_2 elements a burnup of 1.4%. Experience of the contamination of the primary circuit by fission products and the effectiveness of cold traps in decontamination of the coolant are described. Results of measurements of the gas release and leak tightness, made on the discharge of the oxide assemblies, are presented. Sample assemblies were successfully unloaded into molten Pb. Selected parameters of the UC-fuelled reactor are tabulated, and an outline is presented of the preliminary physics measurements. (UK)

18572 ON THE GAMMA-RAY SPECTROMETRIC CONTROL OF RADIOISOTOPIC COMPOSITION OF WATER IN THE PRIMARY COOLANT CIRCUIT OF THE SOFIA REACTOR IRT-1000. Nikoloff, K. (Univ., Sofia). Kernenergie, 10: 309-12(Oct. 1967). (In German).

Relative merits of keeping radiation histories on isotopic content of primary cooling water are discussed. Studies on the IRT-1000, Sofia, are described. Use of γ spectrometric methods for quality control is discussed. Some experimentally determined γ spectra are shown. 11 references. (M.L.S.)

18573 EXPERIMENTS ON THE ZR-3 CRITICAL ASSEMBLY IN CONNECTION WITH THE DEVELOPMENT OF THE WWR-SM CORE. Frankl, Laszlo; Gacsi, Lajos; Szabo, Ferenc; Szaklajda, Laszlo; Varkonyi, Lajos. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 16: 3-33(1968). (In Hungarian).

The ZR-3 critical system was built as a part of the international cooperation for the reconstruction of the WWR-S reactors. The optimum configuration of the WWR-SM reactor and a possible load for the second operational cycle were evaluated on this zero power critical assembly. The results of measurements carried out on these two core configurations are given. (auth)

18574 METAL/WATER EXPLOSIONS. Brauer, Fredrick E. (Humble Oil and Refining Co., Linden, N. J.); Green, N. Wayne; Mesler, Russell B. Nucl. Sci. Eng., 31: 551-4(1968).

The results of water quenching liquid metal reactions are discussed. Experiments involving the use of liquid Al and liquid Pb dropped into cooling water are performed. Cooling water temperatures were varied from 4 to above 60°C. Results are presented. (auth)

18575 LOW-ENRICHMENT URANIUM-METAL EXPONENTIAL EXPERIMENTS. Chezem, C. G. (Los Alamos Scientific Lab., N. Mex.); Steinke, R. G. Contract W-7405-eng-36. Nucl. Sci. Eng., 31: 549-50(1968). (LA-DC-9116).

A study of low average enrichment, uranium-metal exponential columns is described. Unreflected 21 in. dia uranium cylinders of 4.29, 6.53, and 9.12% ^{235}U enrichment are studied. Results are presented. (D.C.C.)

18576 THE DIDO HOT SOURCE; ENHANCEMENT OF 100–400 MeV NEUTRON INTENSITIES BY RETHERMALIZATION. Egelstaff, P. A.; Moffitt, R. D.; Saunderson, D. H. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 59: 245-53(1968).

The intensity of neutrons from a reactor beam hole with energies in the range 100–400 MeV has been considerably improved by introducing a moderator block operating at 1100°C. The factors governing the choice of material for the block, including physical, chemical and neutron rethermalization properties, are discussed. The results of calculations for optimizing the design are compared with the observed thermal performance. Measurements of the modification to the neutron flux spectra are described which show a higher degree of rethermalization than anticipated and an acceptable loss of integrated flux caused by the introduction of the in-pile assembly. (auth)

18577 CRITICALITY OF ARRAYS OF ^{233}U SOLUTION. Lloyd, R. C. (Battelle Memorial Inst., Richland, Wash.); Clayton, E. D.; Chalmers, J. H. Contract AT(45-1)-1830. Nucl. Appl., 4: 136-41(Mar. 1968). (BNWL-SA-1078).

The results of neutron multiplication measurements performed with arrays of ^{233}U solution apply to criticality safety considerations in handling solutions at a concentration of $\approx$ 330 g ^{233}U/liter and are useful in checking computational methods. The measurements were made with ≤ 17.3 kg ^{233}U in both reflected and unreflected arrays. Critical numbers of bottles were determined as a function of spacing, and the effect of adding moderating material between the bottles comprising an array was also examined. Monte Carlo calculations were found to reproduce the experimental data reasonably well, with k_{eff} being computed to within about 0.03 of unity for those cases compared. (auth)

18578 COMBINED RADIATION AND HEAT TREATMENT OF LIQUIDS IN NUCLEAR REACTOR UNDERGROUND. Schlicht, G. R. A. O.; Lange, H. (to Deutsche Erdol-Aktiengesellschaft). Canadian Patent 770,698. Oct. 31, 1967. Priority date Nov. 8, 1962, Germany.

A reactor located at a depth of 20 meters or more is described for the treatment of bitumens in underground strata. The arrangement consists of a perforated, elongated outer casing in a boring with the nuclear reactor chamber in the lower end. A treatment chamber and reflecting chamber surround the reactor vessel. Piping conducts liquids in both directions to the head of the casing. There are two flow systems; one called primary, contains no reactor poisons and flows through the reactor vessel as moderator or coolant, the other called secondary, flows only through the concentric treatment and reflecting chambers. Control is achieved by sheathing the small fuel particles with two different metals, so that differential expansion alters the distance between ring-shaped bodies of oval cross section. The fuel particles circulate in a conduit. Spent fuel is dropped into a suitable container below the reactor. (F.S.A.)

18579 SWIMMING-POOL TYPE REACTOR. Aizu, Tadashi (to Hitachi Ltd.). Japanese Patent 1967-6160. Mar. 24, 1967. Filed Apr. 18, 1964.

In the swimming-pool type reactor proposed, cooling water can be forcibly circulated through the reactor core in a simple manner, thereby enabling the power-up of the reactor. A bridge is installed spanning the circular water pool; this bridge can rotate along the circumferential rail. The reactor core, which rotates along with the bridge, is suspended near to the pool bottom so as to be in contact with the pool wall. The so-called water-collector cylinder is installed directly connected to the bottom of the reactor core. A pipe, which goes out of the pool through the center of the pool bottom, is connected to this water-collector cylinder; the part of this pipe which is in the pool can rotate with the cylinder (and hence the core). In this way, cooling water can be forcibly circulated through the reactor core. (NSA of Japan)

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 16857, 16936, 16937, 16939, 16947, 17113, 17114, 17127, 17151, 17153, 17158, 17162, 17188, 18077–18079, 18099–18102, and 18107.

18580 (BAW-3238-13) NONUNIFORM HEAT GENERATION EXPERIMENTAL PROGRAM. Final Report. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). Apr. 1967. Contract AT(30-1)-3238. 241p. (EURAEC-1846). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

The results of an experimental and analytical program to determine how irregular heat flow through reactor channels affects the operating conditions that cause critical heat flux are presented. Tubular specimens with four axial power shapes and annular specimens with five power configurations were tested, and the effort to correlate the experimental data with empirical and analytical models is reported. Critical heat flux conditions were run in uniform and nonuniform axial flux shapes at 1000, 1500, and 2000 psia pressures, 0.5, 1.5, and 2.5 $\mathrm{lb/hr{-}ft^2} \times 10^6$ mass velocities, and 20, 50, 100, and 150°F inlet subcooling conditions. The tubular test sections were 0.446-inch ID tubes 72 inches long. The annular channels had 1.053-inch OD and 0.607-inch ID. The analysis presents observations regarding critical heat flux location and magnitude along with equations which evaluate the effect of operating parameters on critical heat flux, location and magnitude. (H.D.R.)

18581 (BNWL-273(Vol.2)) COMPARATIVE COSTS OF OXIDE FUEL ELEMENTS. VOLUME 2. PROCESS FACILITY DESCRIPTION AND COST ESTIMATES. Merker, L. G.; Burnham, J. B.; Deonigi, D. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1966. Contract AT(45-1)-1830. 77p. Dep. CFSTI.

The feasibility of fabricating 1 ton/day quantities of reactor fuels enriched with UO_2, and PuO_2 was investigated. Also, fuel manufacturing and construction costs were estimated, and work was performed on the conceptual design of facility and equipment. One-ton per day study plants were conceptually designed for the manufacture of a reference fuel element by pelleting and vibrational compaction processes. Six cases were studied, and the basic assumptions, objectives, and manufacturing cost analyses are reported in Volume 1. The plant design assumptions were based on present or projected processes, and on the available, or calculated plutonium dose rate information. From available dose rate information, it seems apparent that fully decontaminated plutonium produced from most power reactors can be fabricated in shielded glovebox facilities. The conceptual plant descriptions, and estimated costs for the buildings, equipment, and shielding are presented. Even though new processes may be developed or present processes eliminated, the conceptual designs and costs presented should remain nearly valid for several years. The cost of fuel elements produced by similar processes is comparable for the different enrichments, and deviations from the study costs presented in Volume 1 would occur principally from changes in cladding and fuel prices. Cost variations are presented in Volume 3. 5 references. (auth)

18582 (CEA-R-3173) ETUDE EXPERIMENTALE DES DEPRESSIONS DE FLUX ET ANTIREACTIVITES CREES PAR LES DISPOSITIFS D'IRRADIATION. (Experimental Study of Flux Depressions and Antireactivities Created by Irradiation Loops). Roche, Dominique (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1967. 120p. (In French). Dep.

Thesis. Submitted to Grenoble Univ., France.

Methods for fast computing of thermal flux depressions and reactivities created by irradiation-loops in natural water reactors are studied. The classical methods of approximation which have been used are: diffusion theory or absorption-probability calculations for the flux-depression and perturbation theory for the antireactivities. Pertinent formulae are compiled together with graphs from theoretical calculations These formulae and graphs have been checked from numerous experiments which show that the approximations used here are quite close to the actual physical situation, even when the theories are based from assumptions which are not verified. (auth)

18583 (CEA-R-3329) EVOLUTION D'ECHANTILLONS DE BIOXYDE D'URANIUM APRES RUPTURE DE GAINE. (Changes in Uranium Dioxide Samples After Can Rupture). Guyonvarh, Michel; Le Meur, Roger (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 19p. (In French). Dep.

UO_2 samples obtained from punctured cans were irradiated in the presence of CO_2 temperatures below 450°C. During irradiation, the detection of fission products indicated that an increase of the outside surface of the samples had occurred. After irradiation, examination showed an increase in volume together with a partial oxidation of UO_2 to U_3O_8. This evolution is attributed to the presence of free oxygen in the CO_2. This hypothesis is confirmed by heating a non-irradiated sample for 150 hours in air at 300°C. It is thus necessary to avoid the presence of air. (auth)

18584 (CEA-R-3330) AMELIORATION DU SEUIL DE DETECTION DES RUPTURES DE GAINE. I. ESSAIS SPECIAUX POUR AMELIORER LE SEUIL DE DETECTION DES INSTALLATIONS DE D.R.G. DES REACTEURS DE PUISSANCE. II. ESSAIS DE BALAYAGE SOUS SCINTILLATEUR AVEC GAZ VIEILLI A LA D.R.G./E.D.F. 2. (Improvements of the Sensitivity of Burst Cartridge Detection. I. Special Tests for Improving the Sensitivity of Burst Cartridge Detection Equipment in Power Reactors. II. Scintillator Purge-flow Tests Using Aged Gas in the B.C.D./E.D.F. 2). Vasnier, Fernand (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 23p. (In French). Dep.

The tests carried out on fission product detectors by a process in which gas is continuously injected in front of the scintillator are described. Using this system, the background is reduced and perturbations caused by pneumatic switches on the prospection circuits are eliminated. The quality of the signals thus obtained permits better processing of the data and thus leads to a possible improvement in the sensitivity of burst cartridge detection. Tests carried out with both fresh and aged gases for economic analysis are described. Reduction of the background is less pronounced, but the advantage of the stable signals is conserved. (auth)

18585 (CEA-R-3338) MESURE DE FLUX DE NEUTRONS THERMIQUES PAR ACTIVATION D'AIR. (Measurement of a Thermal Neutron Flux Using Air Activation). Guyonvarh, Michel; Lecomte, Pierre; Le Meur, Roger (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 44p. (In French). Dep.

It is necessary to know, in irradiation loops, the thermal neutron flux after the irradiation device has been introduced and without being obliged to wait for the discharge of this device. In order to measure the flux and to control it continuously, one possible method is to place in the flux a coiled steel tube through which air passes. By measuring the activity of ^{41}Ar, and with a knowledge of the flow rate and the temperature of the air, it is possible to calculate the flux. An air-circulation flux controller is described and the relationship between the flux and the count rate is established. The accuracy of an absolute measurement is about 14%; that of a relative measurement is about 3%. The measurement can be carried out equally well whether the reactor is operating at maximum or at low power. The measurement range goes from 10^9 to 10^{15} n cm^{-2} sec^{-1}, and it would be possible after a few modifications to measure fluxes between 10^5 and 10^{15} n cm^{-2} sec^{-1}. Finally, the method is very safe to operate: there is little risk of irradiation because of the low specific activity of the ^{41}Ar formed, and no risk of contamination because the decay product of ^{41}Ar is stable. This method, which is now being used in loops, is thus very practical. (auth)

18586 (CONF-661056-1) UTILISATION D'UN CALCULATEUR NUMERIQUE POUR LA SIMULATION D'UN REACTIMETRE ASSOCIE A UN REACTEUR. (Use of a Digital Computer for Simulation of Reactivity Associated with a Reactor). Amblard, J. Cl.; Cheruy, J.; Gariod, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec. 20, 1966. 22p. (In French). (INT/EL-66-1973).

From Conference on Physics Experience in the Start Up of S.F.E.R. Calculator, Saclay, France.

Operation of a reactor demands a knowledge at any instant of the reactivity and power. Only the latter is accessible to a measurement, the result being fed to a reactivity meter for determination of the former. This instrument represents the characteristics of the reactor on the basis of an introduced mathematical model, which takes into account the existence of several delayed neutron groups. An attempt was made to reduce the number of neutron groups in the reactivity meter. This problem is approached by placing a reactor model (with the usual 6 groups) in series with the reactivity meter model, in which the number of groups has been reduced by the method proposed. It is demonstrated that the six groups can be replaced by three, involving no more than 1% error in the reactivity measurement. (auth)

18587 (CURL-15) THEORY AND MEASUREMENT OF NEUTRON IMPORTANCE IN NUCLEAR REACTORS. Greenspan, Ehud (Cornell Univ., Ithaca, N. Y. Nuclear Reactor Lab.). Sept. 1966. 191p.

Thesis.

A combined theoretical, calculational, and experimental study of the phase space distribution of neutron importance and other adjoint functions for a nuclear reactor is made. A procedure for modifying transport codes, designed to calculate the neutron density distribution, for adjoint functions calculations is formulated. Following this formulation the multigroup computer codes DOSE-A and PONE-A are prepared in Fortran-63 for the CDC 1604 to calculate the thermal importance function in the S_4 and the consistent P_1 approximations. The thermal importance function fine structure in the Cornell University Critical Assembly (ZPR) lattices is calculated with these codes and employed for computation of unit cell reactivity coefficients, for computation of bilinear weighted thermal group cross sections and for studies of the thermal neutron balance. A significant anisotropy in the importance function distribution is observed for these lattices and the consistent P_1 approximation is not adequate. The reactivity disadvantage factors for 1/v and for energy independent thermal absorbers are found to be smaller than the neutron density disadvantage factor. Bilinear weighting of the thermal group cross sections results in a 2% higher value for Σ_a/Σ_s and in a 0.3% higher value for Σ_f/Σ_a of the 1.5:1 ZPR lattices as compared to flux weighting only. It is also found that the effect of the slowing down sources on the thermal neutron balance can be studied conveniently in the adjoint formulation. Such a study shows that the assumption that the source of thermal neutrons comes from proton collisions only results in an overestimate of ηf by less than 0.1% for the 1.5:1 ZPR lattices. The level of the highest group importance function in the moderator of the unit cell is shown to be a good estimate for ηf. A procedure to maximize ηf by redistribution of the fuel isotopes across the fuel element is developed and a 0.65% increase in the calculated value of ηf is obtained with a variable enrichment fuel rod in the 1.5:1 ZPR lattices. This optimization requires knowledge of both the importance function and the flux fine structure. A procedure for the unit cell homogenization for the purpose of adjoint function calculations is also formulated. Methods for the measurement of the importance function are investigated. Radial and axial traverses of the total neutron importance are measured with a small boron sample for the 1.5:1 ZPR core. Similar traverses of the thermal statistical weight are measured with a small cadmium sample and traverses of the importance of the fission neutrons from spontaneous fissions of a tiny ^{252}Cf source are also measured. No substantial difference between the boron and the cadmium measurements are observed. The radial and axial traverses of the ^{252}Cf fission neutron importance fit very well to a J_0 Bessel function and to a cosine function, respectively, and give accurate values of the geometric bucklings for the reactor. Few group diffusion theory calculations for the homogenized reactor, when corrected for heterogeneity and spectral effects, agree well with the measured traverses of the reactivity coefficients and of the fission neutron importance. (auth)

18588 (RT/FI-(67)28) BURNUP OF PRESSURIZED OR BOILING WATER REACTORS. Buffoni, G.; Loizzo, P.; Lopez, S.; Petilli, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 175p. (CONF-670645-1). Dep.

From Symposium on Advances of Reactor Theory, Karlsruhe, Germany.

A model was developed for calculating the flux profile in large boiling or pressurized water reactors incorporating the control rod movement, the burnup, and the influence between flux distribution and nuclear constants. The model is applicable to reactors with stainless steel, Zr, or Al-clad fuels of UO_2, UO_2-PuO_2, or UO_2-ThO_2 and cruciform control rods of boron steel. Nuclear constants and critical data obtained with the BOLERO code based on the model were verified by comparison with experimental data. BOLERO was written in FORTRAN II for the IBM 7094. The code operation and input-output procedure are described and results of test calculations are presented. (H.D.R.)

18589 (ORNL-tr-1876) BASIC RESEARCH ON DESIGN AND PRACTICE RELATED TO PRESTRESSED CONCRETE PRESSURE VESSELS. (PART 1). Fujita, Kametaro. Translated for Oak Ridge National Lab., Tenn.), from Konkurito Janaru, 5: No. 9, 18-32(1967). 27p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

The studies described on the utilization of prestressed concrete pressure vessels include: the mechanical properties of concrete at high temperature, creep of concrete, and relaxation of prestressed concrete steel material; effects of concrete creep on thermal stress calculations for prestressed concrete cylinders; stress determination of pressure vessels by the three-dimensional photoelasticity technique; and methods for circumferential prestressing cylinders of very large diameters. (D.C.C.)

18590 (UCRL-Trans-10217) REACTOR CALORIMETRY. Kott, J.; Kovar, Z. Translated by V. Newton for Univ. of California Lawrence Radiation Lab., Livermore, from Jad. Energ., 12: 289-96(1966). 34p. Dep. CFSTI. JCL $3.60 fs, $1.25 mf.

An abstract from the original paper appears as NSA 20: 46968. (D. C. C.)

18591 STABILITY OF THE COUPLED-CORE REACTOR AS A TIME-LAG SYSTEM. Goryachenko, V. D. At. Energ. (USSR), 23: 548-9(Dec. 1967). (In Russian).

The dynamic equation of the stability of an idealized coupled-core reactor includes terms containing a constant time lag T. These terms indicate that there is a delay before the neutrons generated in the first core participate in a fission reaction in the second core. Calculations were carried out to solve this problem on the basis of N. N. Krasovkii's theory for time-delay systems. These calculations allowed broader stability conditions than were found possible by means of the earlier method of H. Murray et al. The functional derived indicated that the reactor would operate under asymptotically stable conditions. The stability does not depend on the concrete value of the time lag T and the other parameters of the system. (TTT)

18592 CALCULATION OF TRANSIENTS IN NUCLEAR REACTORS. Zaharov, B. A.; Mirzoyan, A. R. At. Energ. (USSR), 23: 552-3(Dec. 1967). (In Russian).

An equation was derived for the self-regulating operation of a reactor, the core of which contains simultaneously the moderator and the coolant. Since the temperature of the coolant entering the core is a function of time, it was attempted to determine how this inlet temperature affects the outlet temperature when the reactor power level and the coolant temperature change relatively slowly under normal operation. No generalized solution could be derived, but in the partial case, e.g., at a low flow rate of the coolant in large reactors, when the time constants of the core processes satisfy the relation $\tau = 1/\lambda$ (λ being the decay constant of the delayed neutrons), the system may be solved exactly by a squaring method. The calculations showed that the correlation between the reactor power level and the coolant inlet temperature is determined by a Bernoulli equation. On this basis another equation was derived to calculate the outlet temperature established by feedback under self-regulating conditions. (TTT)

18593 EXPANSION METHOD FOR NONLINEAR BOUNDARY-VALUE PROBLEMS. Canosa, Jose (General Electric Co., Pleasanton, Calif.). J. Math. Phys. (N.Y.), 8: 2180-3(Nov. 1967).

A homogeneous nonlinear boundary-value problem, which reduces to the Helmholtz equation when the nonlinearity is removed, is solved by an expansion method using as a basis the eigenfunctions of the linear Helmholtz equation. The nonlinear differential equation is reduced to a nonlinear algebraic system in the expansion coefficients, which can be easily solved with any desired degree of accuracy. It is found that with only three terms in the eigenfunction expansion, a satisfactory agreement with the exact numerical solution of the problem is obtained, even for strongly nonlinear cases. Solutions are presented both in one-dimensional slab and cylindrical geometries. It is also shown that the method can be applied to inhomogeneous problems. (auth)

18594 COMPUTER SIMULATION OF A REACTOR AND ASSOCIATED REACTIVITY METER. Amblard, J. C.; Cheruy, J.; Gariod, R. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 120, 23-36(Nov. 1967). (In French).

Operation of a reactor demands a knowledge at any instant of the reactivity and power. Only the latter is accessible to a measurement, the result being fed to a reactivity meter for determination of the former. This instrument represents the characteristics of the reactor on the basis of an introduced mathematical model, which takes into account the existence of several delayed neutron groups. An attempt was made to reduce the number of neutron groups in the reactivity meter. This problem is approached by placing a reactor model (with the usual 6 groups) in series with the reactivity meter model, in which the number of groups has been reduced by the method proposed. It is demonstrated that the six groups can be replaced by three, involving no more than a 1% error in the reactivity measurement. (auth)

18595 RAPID MEASUREMENT OF THE SUB-CRITICAL STATE OF SOME NUCLEAR REACTORS. Valat, Jean; Weill, Jacky (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 265: 1500-3(Dec. 18, 1967). (In French).

The reactor is excited periodically by source pulses. Its pulse response h(t) is integrated over the same time beginning at four different moments. The integrals are subtracted two by two. The ratio of the two differences obtained furnish α, the inverse of the dominant time constant of h(t), providing that the numerous independent parameters are chosen judiciously. The measurement is rapid and the precision more than sufficient to control the reactor. (tr-auth)

18596 SUBATMOSPHERIC CONTAINMENT. Noble, John H. (Stone and Webster Engineering Corp., Boston). Nucl. Eng. Design, 6: 489-93(1967).

A reactor containment concept is proposed in which the reactor system is contained in a dry container which normally is maintained at subatmospheric pressure. Following a loss-of-coolant incident, the containment pressure is returned to subatmospheric by the use of redundant spray cooling systems. Subatmospheric containment is a departure from previously proposed containments, in that previous designs have remained above atmospheric pressure indefinitely following the hypothetical incident with continuous leakage resulting. Subatmospheric containment results in the absolute termination of leakage following the hypothetical incident, with subsequent minimization of all biological effects due to the incident. Charcoal and particulate filters, chemical sprays, or other fission product removal devices in the containment are not required. (auth)

18597 FAIL-SAFE REACTOR SYSTEM. Tsunoda, Tomio; Gotoh, Seiichiro; Suzuki, Eiji (Nippon Atomic Industry Group Co. ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 4: 614-22(Dec. 1967).

A highly reliable solid state reactor safety system operated in dynamic mode is described. Direct current signals from detectors for reactor control are converted to pulse signals, which are continuously generated by the circuit until some abnormal condition occurs. The design and construction of several kinds of logic circuits used for reactor control are explained in detail. The fail-safe property of the circuits has been ascertained by tests, and effects due to temperature variation are negligible in a range 10 ~ 50°C. Results of reliability analysis show that the reactor safety system described, with redundant dynamic logic circuits, has the necessary qualities to assure highly reliable and safe operation of reactor plants. (auth)

18598 VARIATIONAL PRINCIPLES FOR CALCULATION OF ARBITRARY RATIO OF PROCESSES IN CRITICAL ASSEMBLIES. Dwivedi, S. R. (Bhabha Atomic Research Centre, Trombay, India). J. Nucl. Energy, 22: 123-5(Feb. 1968).

It is shown that the principles of Lewins and Pomraning are the same to the first order, and that Pomraning's principle can be derived from that of Lewins. (UK)

18599 THE j_N METHOD FOR NEUTRON TRANSPORT PROBLEMS IN A BARE SPHERE. Asaoka, T. (EURATOM, Ispra, Italy). J. Nucl. Energy, 22: 99-121(Feb. 1968).

The j_N method is a new analytical approach which has emerged in the course of developing the multiple collision method. By means of this method, neutron transport problems for a bare sphere can be solved efficiently in the context of a multigroup model under the assumption that the scattering of neutrons is spherically symmetric in the laboratory system. Stationary transport problems are treated as a special case of time-dependent problems, and it is then easy to obtain the asymptotic time behaviour, critical condition or the value of the effective multiplication factor. A comparison of numerical results for these stationary quantities with those obtained from other methods shows that the j_3 approximation gives a comparably accurate result to the S_4 calculation for all bare spheres of interest. Numerical examples for time-dependent problems are shown by the use of a one-group model (which is equivalent mathematically to a multigroup model in a non-multiplying medium without up-scattering of neutrons). For a sphere in which the maximum transit time of neutrons is finite, there always exists an asymptotic exponential time decay of the neutron flux, and the numerical values of the decay constant in the j_1 approximation are close to Judge and Daitch's results. On the other hand, for a sphere where the maximum transit time of neutrons is infinite, it is shown that there exists a simple condition under which no asymptotic exponential decay can be observed. In addition, the transient time behaviour of neutrons obtained from the j_2 or j_5 approximation is shown and compared with Monte Carlo results. (auth)

18600 ENGINEERING DEVELOPMENT FOR SODIUM SYSTEMS. Eickhoff, K. G.; Allen, J.; Boorman, C. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 873-95 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

The design of 13 Na rigs is outlined, and their leak testing and rig purity measurement and control methods are discussed. The Na pump design being studied incorporates a hydrostatic lower bearing; performance curves are given. Wear tests are continuing on suitable materials Na and Na-saturated Ar. For the testing of core components a fuel element test rig was constructed; core flow and temperature distribution studies are summarized. The programme of experiments on Na/H_2O reactions in steam generators is surveyed, and the rig parameters are listed. (UK)

18601 RECENT THEORETICAL WORK IN THE UNITED STATES ON FAST REACTOR PHYSICS. Hummel, H. H. (Argonne National Lab., Ill.); Loewenstein, W. B.; Greebler, P.; Nims, J. B.; Reynolds, A. B.; Pitterle, T. A. pp 493-511 of Fast Breeder Reactors. Evans, P. V. (ed.). Oxford, Pergamon Press, 1967.

From British Nuclear Energy Society Conference on Fast Breeder Reactors, London. See CONF-660502.

Studies in connection with the development of codes for the production of fast reactor group cross-sections include the accuracy of resonance integral approximations, and the role of flux correction factors. The theoretical correlation of results from the wide variety of fast neutron critical and ancillary experiments is discussed, and the effect of parameter uncertainties is considered. Conceptual studies concentrated on the neutronics of 1000 MW(e) sodium-cooled systems utilizing the Pu-^{238}U cycle are discussed. Preliminary work on He-cooled and steam-cooled systems is mentioned. Dynamic studies included the interaction of zoned cores, and the degree of homogeneity required in a mixed oxide fuel for the Doppler effect to be fully exerted in a transient. (UK)

18602 BUILDUP FACTORS OF GAMMA-RAY PENETRATION FOR MULTIPLE LAYERS IN REACTOR SHIELDING. Kitazume, Mitsuyuki; Ogushi, Akira (Hitachi Ltd., Toyko). Hitachi Hyoron, 49: No. 7, 1-8(July 1967). (In Japanese).

With the purpose of investigating the available calculational methods for the gamma-ray dose build-up factors necessary for shielding design, experiments were carried out on the gamma-ray penetration through multiple layers by the use of a one-direction, plane 10 Ci ^{60}Co source, and the accuracies of Kalos', Broder's, and Kitazume's empirical formulae were examined. The shielding materials employed were water, iron and lead, and by combining them, shielding plates of up to four layers with a maximum total thickness of 8 mfp were tested. When using the experimental values of the one-layer build-up factors, for a two-layer shielding plate, light and heavy ones in order, the values by Kitazume's formula agree with the experimental ones within several percent. For the two-layer plate of heavy and light ones in order, Broder's formula gives several to 20% smaller values; by the combination of Broder's and Kitazume's formulae, the agreement is 5 to 15%. On the whole, Broder's and Kalos' formulae do not give good approximations. Using the calculated values of the one-layer build-up factors, the values by Kitazume's formula are 5 to 15% larger than the experimental ones. From the above, it is seen that in its application to the actual shielding design the combination of Broder's and Kitazume's formulae gives the values of the build-up factor, accurate within 15%, for the multiple layers. (NSA of Japan)

18603 IRRADIATION BEHAVIOR OF CORED U_3Si FUEL ELEMENTS. Feraday, M. A.; Chalder, G. H.; Cotnam, K. D. (Atomic Energy of Canada Ltd., Chalk River). Nucl. Appl., 4: 148-53(Mar. 1968).

Zircaloy-clad specimens of U_3Si were irradiated in pressurized water at rod powers of 480 to 565 W per centimeter of length to burnups of ≈5500 MWd/tU. The rate of swelling of the U_3Si, which is rapid during the early part of the irradiation, appears to decrease with increasing burnup. The increase in external diameter was much less for these fuel elements than for earlier ones. The improvement is attributed to the provision of a central void which became filled by the U_3Si during irradiation. (auth)

18604 MEASURING BURN-UP IN URANIUM FUEL ELEMENTS. Bresesti, Marcello (Joint Nuclear Research Center, Ispra, Italy). Euratom Bull., 6: 104-8(Dec. 1967).

Methods for measuring fuel burnup in uranium are discussed. Use of the gamma scanning technique is discussed; sample spectra are shown. The use of computer programs for calculation of neutron densities is outlined. (M.L.S.)

18605 INVESTIGATION OF TANGENTIAL CHANNELS FORMED BY LIFTING THE REACTOR CORE. Frankl, Laszlo; Szabo, Ferenc; Varkonyi, Lajos. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 16: 35-43(1968). (In Hungarian).

The physical experiments carried out at the horizontal channels of the WWR-SM Reactor require high thermal neutron flux with a low fast neutron background. For the improvement of thermal to fast flux ratios tangential channels can be constructed. Instead of the tangential channels whose construction is very costly, the lifting of the core and the problems of the coupling between the bottom reflector and the already existing horizontal channels had been investigated by a special series of measurements as part of the zero power experiments for the reconstruction of the WWR-S reactor. The ratios between thermal, epithermal and fast neutron fluxes and gamma background measured at the radial channels and the "tangential" channels with the latter positioned at several different heights relative to the core are described; results are given. (auth)

18606 GENERALIZED FORMULATION OF POINT NUCLEAR REACTOR KINETICS EQUATIONS. Becker, Martin (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. Nucl. Sci. Eng., 31: 458-64(1968).

The most general current formulations of the point reactor kinetics equations permit the flux shape function to be time dependent. This permissibility has led to the development of a class of space-time analyses referred to as adiabatic or quasistatic. The use of time-independent importance weighting, however, can lead to difficulties, as is shown in an example. Point kinetics equations are derived from a variational principle in such a way as to permit time-dependent importance shape functions. "Extra" terms due to the explicit time dependence of the shape functions appear, and normalization conditions are obtained by which these terms can be eliminated. Additional differences from conventional form appear if one chooses to use different importance shape functions for flux and precursor equations, but these differences can be neglected for many cases of practical interest. (auth)

18607 INTERMEDIATE NEUTRON RESONANCE ABSORPTION IN HETEROGENEOUS SYSTEMS. Ishiguro, Yukio; Takano, Hideki (Japan Atomic Energy Research Inst., Tokyo). Nucl. Sci. Eng., 31: 388-95(1968).

A two-term rational approximation is proposed for the calculation of the collision probabilities for regular arrays of cylindrical fuel rods and cluster-type fuel elements. Comparisons with exact and Monte Carlo calculations show that its accuracy is quite adequate for the analytical approach to calculating resonance absorption under the flat-flux approximation. Using the two-term approximation, an analytical expression for calculating resonance integral is given for intermediate resonances. Specific examples are computed numerically for the 6.7-eV resonance of ^{238}U for the square lattices of $^{238}UO_2$ and ^{238}U-metal rods in water and carbon. The present results are found to be in good agreement with Monte Carlo calculations, but are slightly higher in value due to the flat-flux approximation. The Bell factor proposed by Leslie et al., also overestimates the resonance integral of the 6.7-eV resonance of ^{238}U. (auth)

18608 SYNTHESIS METHOD OF UNCERTAINTY ANALYSIS IN NUCLEAR REACTOR THERMAL DESIGN. Fenech, Henri; Gueron, Henri M. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 31: 505-12(1968).

The principal methods of core design uncertainty analysis are critically reviewed. The overconservatism of the Deterministic Method, which aims at ensuring that the design limits cannot be exceeded in the most loaded channel (or at the most loaded spot), leads to a probabilistic approach in which the probability of such an event is evaluated. Recent work in this direction is discussed. It is emphasized, however, that a probabilistic reliability evaluation must cover the whole core, and not only its most heavily loaded element. The Synthesis Method fulfills this requirement without demanding the use of computers. The Synthesis Method also allows the use of a realistic space-dependent reliability criterion. The various methods under review are compared in their application to a fast gas-cooled reactor core. The power levels corresponding to a given reliability are calculated and the Synthesis Method is seen to be more conservative than the classical Statistical Method and less conservative than the Deterministic Method. 16 references. (auth)

18609 VARIANCES AND COVARIANCES OF NEUTRON AND PRECURSOR POPULATIONS IN TIME-VARYING REACTORS. Clarke, W. G.; Harris, D. R.; Natelson, M.; Walter, J. F. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 31: 440-57(1968).

The fluctuating populations of particles in a reactor are described in usual kinetics studies by the numbers of neutrons and precursors which, in the absence of feedback mechanisms, can be identified with first moments of the population distributions. At a higher level of description, variances and covariances of the neutron and precursor populations are determined from equations similar to the first-moment equations. The behavior of these first and second moments for time-varying reactors is explored here analytically and numerically, and inferences are made as to the effect of initial reactor conditions and modes of reactivity change on this dynamic behavior. 12 references. (auth)

18610 RECOMMENDED FIRE PROTECTION PRACTICE FOR NUCLEAR REACTORS. Nat. Fire Codes, 9: 802.1-71 (1967-68).

Guidance on practices necessary for fire and explosion protection in nuclear reactor facilities is presented. General information on reactor operating principles and potential hazards is discussed, and organization and planning procedures are recommended for fire protection of specific reactor types. The design, construction, and physics of reactors are briefly reviewed. (H.D.R.)

18611 IMPROVEMENTS IN NUCLEAR REACTORS. (to Babcock and Wilcox Ltd.). British Patent 1,098,745. Jan. 10, 1968. Priority date Mar. 28, 1964, Germany.

In a nuclear reactor having the core within a pressure vessel arranged for the upward flow of primary coolant through the core and with steam generating heat exchange means arranged for cooling the primary coolant, at least some of the heat exchange means are disposed higher than the reactor core in passage means leading primary coolant fluid in a direction away from the vertical axis of the pressure vessel and towards the adjacent pressure vessel wall. The steam generating heat exchanger means occupies an annular region co-axial with the vertical axis of the core and of smaller diameter at its upper end than at its lower end. The heat exchange means consists of tube blocks placed side by side to form the annulus. Each tube block consists of a number of specially curved layers of different spherical radii at corresponding distances from the pressure vessel center, and each tube layer is formed by a row of tubes bent in serpentine fashion. (B.L.M.)

18612 DEVICE AND METHOD FOR THE HEAT INSULATION OF REACTOR CHANNELS. Ohlmer, Eggert; Dufresne, Jacques; Finzi, Sergio (to European Atomic Energy Community). British Patent 1,093,725. Dec. 6, 1967. Priority date Mar. 16, 1964, Germany.

In order to insulate a liquid-cooled nuclear reactor channel formed by an inner hollow fuel sheath and an outer pressure tube spaced from the inner sheath to define an insulating clearance between the two, the clearance is divided into a number of chambers by means of flow-restricting elements mounted between the sheath and tube. Flow communication is allowed between the clearance chambers and the hollow sheath to equalize the fluid pressure between the two. A cooling liquid(s) is forced to flow downwardly in the clearance and in the sheath with the liquid flowing in the clearance containing dissolved gas in such quantity that the gas is evolved in the clearance as the liquid passes through. .(B.L.M.)

18613 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Dunn, Peter Douglas; Whitby, Herbert Clucas;

Rice, Graham (to United Kingdom Atomic Energy Authority). British Patent 1,093,618. Dec. 6, 1967. Filed Dec. 8, 1964.

A fuel element design is proposed to improve the heat exchange characteristics of the element by making the element porous and feeding a liquid coolant to the element so that the coolant diffuses through the element and leaves the element as a vapor. Preferably, the porosity of the element is nonuniform and increases in the direction of coolant flow through the element. The element may be an elongated hollow cylindrical body of porous wall construction enclosed in a liquid tight casing. Liquid coolant is supplied to the casing, and duct means are connected to the interior of the element so that the vaporous coolant is removed from the interior of the element. (B.L.M.)

18614 NUCLEAR FUEL ELEMENTS. (to Union Carbide Corp.). British Patent 1,093,776. Dec. 6, 1967. Priority date Aug. 7, 1964, United States.

A method is described for preparing a nuclear reactor fuel element composed of a fueled core encompassed within an unfueled graphite exterior shell. The fueled core comprises a nuclear fuel material, a refractory material, and a carbonized or graphitized binder. Expanded graphite is present either in the fueled core or in a layer of carbonaceous cement between the core and the shell or in both. The element is prepared by making a mixture for the fueled core of the components specified above, molding the mixture within a rigid graphite exterior shell, heating the unit to cure the thermosetting binder, and baking the unit to a temperature sufficient to carbonize or graphitize the binder and to expand the expanding graphite. (B.L.M.)

18615 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL BEARING BODIES. Hooper, Alan Thomas; Symes, Reginald John (to United Kingdom Atomic Energy Authority). British Patent 1,092,285. Nov. 22, 1967. Filed Feb. 28, 1964.

A method is described for distributing and supporting fissile material in a nuclear reactor core so as to provide a fixed heat transfer surface which is swept by coolant by forming the material into a number of lengths and winding the lengths into a number of convolutions as a multi-start helix about a common axis. Several layers of convolutions may be formed one on the other with hollow spacers interposed between the layers to allow the introduction of neutron absorbing members into the spacers. (B.L.M.)

18616 NUCLEAR REACTOR. Grain, Deryk Ronald (to United Kingdom Atomic Energy Authority). British Patent 1,092,107. Nov. 22, 1967. Filed Nov. 12, 1963.

In a reactor having a core cooled by pressurized liquid the coolant is divided into a main stream and a pressurizing stream by a flow guide. A flow restrictor is provided by which the pressurizing stream can be caused to flow slower and hotter than the main stream. The pressurized stream flows into a pressurizer in which the stream is to develop a coolant pressure related to the temperature of the pressurizing stream. This coolant pressure alone is applied to the main stream as an operational over-pressure. (B.L.M.)

18617 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Smith, Thomas Gavin; Merrett, Dennis John (to United Kingdom Atomic Energy Authority). British Patent 1,096,305. Dec. 29, 1967. Filed Aug. 28, 1964.

An apparatus for cooling a nuclear fuel element during unloading from a reactor used for materials testing or neutron beam production includes an apertured tube moveable into a coolant passage formed through the element. An external seat at one end of the tube is engagable with a portion of the element to partially seal the channel. An internal valve seat is provided at the same end of the element. A float within the tube is dimensioned to close the valve seat. A coolant liquid is supplied through the tube. (B.L.M.)

18618 NUCLEAR REACTOR FUEL ELEMENTS. Oldfield, William; Athawes, Peter Derek (to United Kingdom Atomic Energy Authority). British Patent 1,094,505. Dec. 13, 1967. Filed Feb. 15, 1965.

A plate type fuel element is produced by subjecting an assembly of a core of nuclear fuel material in a main body of cladding material to a bonding process. Pressure is applied progressively from one end region of the assembly to the other. A non-fissile metallic insert is introduced between the core and the body at least at one of the end regions to control the thickness of the fuel material within the element resulting from the pressure bonding process. This type fuel element is suitable for use in a materials testing reactor. (B.L.M.)

18619 NUCLEAR REACTOR FUEL ELEMENT. Gauthron, Maurice (to Commissariat a l'Energie Atomique). British Patent 1,095,245. Dec. 13, 1967. Priority date Oct. 28, 1965, France.

A fuel element particularly suitable for use in a heterogeneous graphite-moderated, natural U fueled, and gas-cooled reactor is made up of a sheath enclosing a number of identical pellets, which are small in height relative to their diameter stacked one above the other. Longitudinal blades unitary with the outer surface of the sheath are provided to increase the rigidity of the element. A thin metallic disc slightly smaller in diameter than the pellets is interposed between each two pellets to form a circular groove into which the sheath is deformed to anchor it to the fuel. (B.L.M.)

18620 NUCLEAR FUEL ELEMENTS. Haigh, Roy Ernest (English Electric Co. Ltd.). British Patent 1,095,153. Dec. 13, 1967. Filed Mar. 13, 1964.

An end cap is described for a nuclear fuel element made up of a hollow, cylindrical, open-ended can containing nuclear fuel. The caps for each end of the can are in the form of a transverse disc portion integral with a cylindrical portion which extends into the can from the disc portion to the end of the can and are separated from the fuel by a disc-like insulating member. An end fitting, which extends coaxially beyond the can, is fitted tightly within the cylindrical portion of each end cap and is in contact only with the end cap. A ring of material substantially more resistant to creep than the material of the end cap is fitted tightly in a circumferential groove formed in each disc portion adjacent to the corresponding insulating member so that each ring lies in loose contact with the interior wall of the can and with the adjacent end cap and insulating member. The contact between the end cap and adjacent insulating member is substantially over its entire cross-sectional area. (B.L.M.)

18621 NUCLEAR REACTOR FUEL ELEMENTS. Coulter, Robert Smith; Oldfield, William (to United Kingdom Atomic Energy Authority). British Patent 1,094,564. Dec. 13, 1967. Filed Apr. 7, 1964.

A method of closing an end of a protective tube for a pin-type fuel element includes assemblying a tubular support member together with the support end in such a manner that a portion of the member is inside the tube end and a portion is outside the tube end with the outer surface of the portion inside the tube end engaging the opposing inner surface of the tube end. An apertured neck is formed on the assembly in the region of the engaged surface by die-swaging, and the aperture is then sealed by welding. (B.L.M.)

18622 NUCLEAR REACTOR FUEL ELEMENTS. Flatley, Peter; Draper, William Charles (to United Kingdom Atomic Energy Authority). British Patent 1,094,902. Dec. 13, 1967. Filed Mar. 13, 1964.

A method is described for producing a black chromate coating on Mg or Mg alloy components, particularly reactor fuel element sheaths, by immersing the component in an aqueous chromating solution. The solution contains 10% wt/vol $Na_2Cr_2O_7 \cdot 2H_2O$, 5% wt/vol $MnSO_4 \cdot 4H_2O$, 5% wt/vol $MgSO_4 \cdot 7H_2O$, and 0.01 to 0.03% wt/vol $AgNO_3$. The solution is maintained at a temperature in the range of 15 to 55°C and at a pH in the range of 2 to 5. This solution produces a chromate coating that has a higher thermal emissivity than that produced by a solution without the addition of $AgNO_3$. (B.L.M.)

18623 NUCLEAR FUEL CYCLE SEMINAR. Report on a Forum Seminar. New York, Atomic Industrial Forum, Inc., 1966. 28p. $7.50.

The introduction and general conclusions of a survey report, "The Outlook for Uranium," on the U. S. uranium market are presented, and comments on the study of uranium production, price, and buying patterns are included. (H.D.R.)

18624 STUDY OF URANIUM ENRICHMENT SERVICES CRITERIA AND PROJECTED CHARGES. Report of the Study Committee on Toll Enrichment. New York, Atomic Industrial Forum, Inc., 1965. 13p. $4.00.

The AEC Uranium Enrichment Services Criteria and the conclusions of the study committee on these criteria are presented. The proposed enrichment services are considered to be responsive to the needs of the nuclear power industry and the ceiling charge of $30 per Kg of separative work appears reasonable and fair. (H.D.R.)

18625 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Coast, Geoffrey; Lockett, George Edward; McIver, Robert Faulds (to United Kingdom Atomic Energy Authority). British Patent 1,098,282. Jan. 10, 1968. Filed Jan. 12, 1965.

A prestressed concrete pressure vessel for a gas-cooled reactor is described with particular arrangement for the steam or vapor generating heat exchangers within the pressure vessel so that circumferential ligaments, which transmit hoop stresses throughout the entire wall thickness, can pass between the heat exchanger or groups of exchangers. The design specifies at least 18 heat exchangers, and reinforcing members are passed through the ligaments between staggered heat exchangers. (B.L.M.)

18626 IMPROVEMENTS IN THE CONTROL OF NUCLEAR REACTORS. Duncombe, Edward; Hurley, Frederick Ian (to United Kingdom Atomic Energy Authority). British Patent 1,098,299. Jan. 10, 1968. Filed Dec. 23, 1964.

A control unit for a nuclear reactor includes a U-tube having vertical limbs and containing a flexible assembly movable through a part of the U-tube positioned in the core of the reactor. The flexible assembly is made up of a sequence of neutron absorbing units followed by a sequence of units of low neutron capture cross section material. The flexible assembly can be moved or retained in position by a pressure differential regulation across the U-tube in such a manner that essentially the greater the differential the smaller the number of neutron absorber units situated in the core. A safety device is provided so that should the pressure differential vanish, auxiliary means act to increase the number of absorber units in the core. (B.L.M.)

18627 NUCLEAR REACTOR SAFETY SYSTEM. Malaval, Claude; Maudinet, Louis (to Commissariat a l'Energie Atomique). British Patent 1,099,747. Jan. 17, 1968. Priority date July 13, 1965, France.

A safety system that provides for the rapid insertion of a neutron-absorbent rod into a vertical channel tube in the core of the reactor is described for use with a liquid-cooled and moderated reactor. When the channel tube is in place in the reactor, the bottom part is occupied by the liquid moderator. The vertical channel tube is removably connected to a stationary part of the reactor, and the neutron-absorbent rod is movable in the channel. A control mechanism is mounted in the top part of the channel tube and supports the rod through a releasable coupling. A shock-absorption system is located in the bottom part of the tube to exert a hydraulic braking effect and a mechanical deformation braking effect on the rod at the end of its fall. A shock-absorption system is also included that absorbs the energy at the end of the travel that the safety rod has accumulated during its rapid insertion in case of an accident. (B.L.M.)

18628 IMPROVEMENTS RELATING TO CHARGING MACHINES FOR NUCLEAR REACTORS. Littleworth, Bertram; Culver, Edward George; Clothier, Alan Frederick (to Fairey Engineering Ltd.). British Patent 1,099,261. Jan. 17, 1968. Filed Sept. 30, 1963.

A charging machine is described that is applicable to gas-cooled reactors of the type having vertical channels in the core to receive fuel elements and control rods and devices. The charging machine includes a main hoist for hoisting the fuel elements vertically out of the reactor and lowering them into the selected standpipe on the charging floor outside the pressure vessel. The charging machine may either rest on or be driven over the charging floor to overlie and be coupled to a selected standpipe mouth. In addition to the main fueling hoist, the charging machine may carry a number of power driven winches, each having a flexible cable wound on its winding drum and extending downwardly for introduction into a standpipe so that it can be used for loading and unloading purposes. The machine includes a rotary magazine of annular form affording a ring of circumferentially-spaced cells each adapted to hold a fuel element with its axis vertical, means for indexing the magazine by rotating it step by step about its vertical axis to bring each cell in turn into predetermined loading position spaced laterally from the main hoisting axis of the machine, and an open-end traverse chute supported for lateral movement in a vertical plane by a parallel-motion linkage that retains it in a vertical orientation during such movement. The traverse chute is movable by remote control means between two positions: first, in alignment with the main fueling hoist where it receives a fuel element from the hoist, and second, in vertical alignment with the indexed cell of the magazine where the element can be transferred into the indexed cell of the magazine. (B.L.M.)

18629 NUCLEAR REACTOR AND FUEL ASSEMBLY THEREFOR. (to Combustion Engineering Inc.). British Patent 1,091,337. Nov. 15, 1967. Priority date Dec. 3, 1964, United States.

A fuel assembly for a nuclear reactor consists of elongated parallel fuel rods retained in evenly spaced relation and arranged in a first group of parallel rods and a second group of parallel rods oriented at right angles to the first group. Each of the rows extends across the entire width of the assembly with the exception of one outer row that extends only a small portion of the way across the width of the assembly. With the exception of the partial row, there is the same number of rows in each direction. Four of these assemblies having the same transverse section as to size and configuration make up the core of a reactor and are oriented to form a cruciform passage centrally of each of the sections with oppositely extending arms of the cruciform configuration being co-planar. (B.L.M.)

18630 SUPPORT FOR CHARGE-DISCHARGE MACHINE FOR NUCLEAR REACTOR. Lemoing, Pierre Rene (to Commissariat a l'Energie Atomique). British Patent 1,091,226. Nov. 15, 1967. Priority date Nov. 4, 1965, France.

A positioning support for a charging machine for a reactor having horizontal channels terminating at given intervals on one of the faces of the reactor comprises a horizontal platform on which are located the machine and at least two beams parallel to one another and to the platform. The beams are connected to the platform by double-action jacks, and retractable locks carried by the platform and the beam respectively co-operate with stationary vertical racks formed with superposed apertures. (B.L.M.)

18631 FUEL ELEMENT FOR A NUCLEAR REACTOR. Boudouresques, B. (to Commissariat a l'Energie Atomique). Canadian Patent 769,154. Oct. 10, 1967. Priority date Oct. 26, 1962, France.

Tubular fuel elements containing fissile material are clad internally and externally with metal sheaths connected and closed by an annular plug of the same material as the sheaths. One of the sheaths is flared at its end to give the plug a cross section of contact greater than the cross section of the fuel tube. The advantage of this structure is the reduction of stress on the lower slugs in a vertical fuel string. Under high temperature and pressure the resistance to "creep" is enhanced by such an arrangement. (F.S.A.)

18632 SHEATHED FUEL ELEMENT. (to Nuklear-Chemie und Metallurgie Gesellschaft mbH). British Patent 1,095,205. Dec. 13, 1967. Priority date Jan. 13, 1965, Germany.

In a reactor fuel element composed of UC sheathed in steel or Zr alloy, the space between the fuel and the sheath is filled with a low-melting metal containing embedded powdered Zr or Zr alloy. This prevents the transfer of C from the fuel to the sheath causing weakening of the sheath. (B.L.M.)

18633 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Babcock and Wilcox Ltd.). British Patent 1,098,599. Jan. 10, 1968. Priority date Mar. 25, 1964, Germany.

A nuclear reactor is described that includes a core to be cooled by a flow of fluid under pressure and heat exchanger tubes located in the fluid flow downstream of the core in a common pressure vessel. The pressure vessel and heat exchanger tubes are encircled by an insulating wall, which cooperates with the inner wall of the pressure vessel to provide an annular flow path between the insulating wall and the pressure vessel for fluid cooled by the heat exchanger tubes. This insulating wall means include a neutron absorbent material adapted to be released into the fluid to render the core subcritical should the wall be fractured during operation. (B.L.M.)

18634 IMPROVEMENTS IN OR RELATING TO GRIDS FOR NUCLEAR FUEL ELEMENTS. Berry, John; Leaver, Bernard; Bell, Douglas Irving; Eccles, Roy (to United Kingdom Atomic Energy Authority). British Patent 1,094,851. Dec. 13, 1967. Filed Jan. 16, 1964.

A cluster fuel grid for elements of circular cross section is made up of an inner annular framework concentrically disposed within an outer annular framework and radial members extending between the inner and outer frameworks. Each radial member comprises an assembly of curved and straight strips, which functions as a straight strut. Transverse members made up of assemblies of curved and straight strips connect adjacent radial members to one another. Further radial members connect the transverse members to the outer framework at positions interposed between the positions at which the first radial members are connected to the outer framework. These further radial members are made up of curved and straight strips with the curved strips being arranged for engagement at at least 4 concyclic points. The fuel elements are arranged with their axes concentrically relative to the framework. (B.L.M.)

18635 HEAT EXCHANGER ARRANGEMENT FOR GAS-COOLED NUCLEAR REACTORS. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,095,209. Dec. 13, 1967. Priority date July 3, 1965, Germany.

A heat exchanger arrangement for a gas-cooled reactor is made up of gas ducts firmly connected at one end to the container of the reactor core and at the other end projecting into heat exchanger vessels surmounting the container of the reactor core with vapor generators positioned within the ends. The gas ducts may be double-walled and contrived to function as preheaters for the liquid medium introduced into the vapor generators. (B.L.M.)

18636 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock and Wilcox Co.). British Patent 1,091,155. Nov. 15, 1967. Priority date Apr. 13, 1964, United States.

A container for an assembly of nuclear fuel pins extending lengthwise of the container is made up of a number of tubular members located side by side and secured together along their length as that part of the periphery of each tubular member is included in the outer boundary part of the periphery of each tubular member, and part of the periphery of each tubular member is included in means that extend between the boundaries. The composite wall of the container comprises struts interconnecting the two boundaries and defining the longitudinally extending cavities, some of which not only contain a fuel element but also provide a coolant flow path. (B.L.M.)

18637 ELECTROMECHANICAL DEVICE GENERATING FREQUENCY MODULATED TRAINS OF PULSES. Bredael, Ivo; Sciuto, Franco (to European Atomic Energy Community). British Patent 1,097,432. Jan. 3, 1968. Priority date Feb. 19, 1964, Belgium.

A device for producing a succession of electrical pulses at varying intervals comprises a source of radiation, a transducer in the path of the radiation operative to convert the radiation reaching the transducer into electrical energy, and a screen rotatable across the path between the source and transducer. The axis of rotation is offset from the path, and the screen has conversion elements parallel to a perpendicular to the axis of rotation of the source, which cross the radiation altering the intensity of the radiation transmitted to the transducer. Such a device is applicable for use as a mechanical oscillator of a nuclear pile. (B.L.M.)

18638 APPARATUS FOR DETECTING BREAKS IN THE FUEL CELL SHEATHS OF ATOMIC REACTORS. Berthod, L. (to Societe Grenoblois d'Etudes et Applications Hydrauliques SOGREATH). Canadian Patent 769,153. Oct. 10, 1967. Priority date Feb. 23, 1962, France.

A scrubbing gas such as He is introduced into the liquid coolant at the top of the channel after the coolant has passed over the fuel rod or slugs. Assuming that the coolant enters at the bottom of the nuclear reactor and is removed at the top, radioactive fission products will be entrained by the gas if there is a break in the fuel sheath. Separation of gas from the liquid by a degasifier in the upper part of the fuel channel allows the detection of activity, if any, in a standard radiation meter. (F.S.A.)

18639 REACTOR CONTAINMENT VESSEL. Komeno, Jin (to Hitachi Ltd.). Japanese Patent 1967-9514. May 23, 1967. Filed June 21, 1965.

By the method proposed, at the time of a reactor accident the pipe of the containment vessel, which leads to the atmosphere can be closed by a "water seal," after a mixture of air and steam has been discharged into the atmosphere; the result is an increased safety and the reduction of construction cost due to the decrease of the peak pressure. A "water seal" chamber is installed near to the bottom of the containment vessel, a pipe connecting the two. A water tank, which is also connected to the containment vessel by a pipe, is installed above the chamber. The chamber and the tank are connected by a thin pipe. A stack is connected to the "water-seal" chamber through a pipe, for discharging a mixture of air and steam at the outset of a reactor accident. (NSA of Japan)

18640 LOADING-UNLOADING MACHINE FOR NUCLEAR REactors. Chemin, P. (to Commissariat a l'Energie Atomique). Canadian Patent 769,824. Oct. 17, 1967. Priority date Dec. 13, 1962, France.

A fueling machine for a gas cooled reactor having either horizontal or vertical fuel channels consists of a sealed shell and a sleeve at its forward end which makes a tight connection with a fuel channel. A revolving magazine is placed between the shell and the sleeve for temporary storage of the channel plugs and fuel cartridges. Within the sleeve is an arm for manipulating the plug and a second arm for the fuel cartridges. Suitable supporting means and aligning mechanisms are also contained in the sleeve with sheilding on the outside. Advantages claimed are reduced length and reduced weight of shielding. (F.S.A.)

18641 NUCLEAR REACTOR PRESSURIZATION. Maldague, P. E. J. M. (to Societe Anglo-Belge Vulcain). Canadian Patent 773,679. Dec. 12, 1967. Priority date Mar. 23, 1962, Luxembourg.

The arrangement is intended to maintain the pressure of a circulating reactor fluid between suitable limits regardless of changing conditions such as power fluctuations. A pressure vessel contains a reactor core, a liquid distributed between the vessel and a pressurizer tank above the core. A non-condensing gas is mixed with the vapor of the liquid and access of additional gas from outside is controlled by a valve. A mixture of gas, vapor, liquid, and fog circulates in the core, pressurizer tank and vessel. Advantage is taken of the heat vaporization and condensation in the tank to maintain pressure within suitable limits during temperature changes in the reactor operation. (F.S.A.)

18642 NUCLEAR REACTOR FUEL ELEMENT PRESSURE TUBES. Kunzli, A. (to Sulzer Brothers, Ltd.). Canadian Patent 773,197. Dec. 5, 1967. Priority date June 13, 1962, Switzerland.

Graphite shapes are pierced with channels containing fuel rods with an annular space around each for coolant flow. A central graphite shape is surrounded by several peripheral shapes to form a fuel-moderator assembly held together by splines and longitudinal tie rods. The relatively short assemblies are joined at the ends by threaded connectors and a long stringer of such assemblies is inserted into a pressure tube. Conventional graphite moderator surrounds the pressure tubes. Uniform coolant flow and protection of the pressure tubes from excessive heat are claimed as advantages. (F.S.A.)

18643 PRESSURE-PROOF COMPLETELY ENCLOSED REACTOR CONTAINMENT STRUCTURE. Bohmann, W.; Held, C.; Martin, A.; Gopel, R.; Wirths, W.; Hunlich, W.; Finsterwalder, U. (to Siemens-Schuckertwerke Aktiengesellschaft). Canadian Patent 771,277. Nov. 7, 1967. Priority date Mar. 20, 1963, Germany.

A hollow, elliptical structure of prestressed concrete shaped like a rugby football is described. The major diameter is about 70m and the minor diameter, 45m. It is intended to contain the reactor, turbines, decay tank and a gantry crane for fuel handling. The structure is set approximately halfway into the ground so that the access openings at either end are at grade level. In the event of excess pressure on the inside, both openings are closed by a sealing device involving convex and concave surfaces. Details of construction and an inside gas-tight metal lining are described. (F.S.A.)

18644 MAGNETIC JACK FOR THE DRIVE OF A REACTOR CONTROL ROD. Takahashi, Jiro (to Meidensha Electric Mfg. Co., Ltd.). Japanese Patent 1967-8119. Apr. 3, 1967. Filed Sept. 25, 1964.

By the method proposed, a heavy reactor control rod can be driven easily with simple construction; the radial dimension can be reduced in comparison with the ordinary magnetic jacks. A spring is used between the member, which moves with the (control rod) drive-rod and another member which is fixed. When the drive rod, and hence the "moving" member, moves upward this spring acts so as to aid the upward movement. (NSA of Japan)

18645 NUCLEAR REACTOR. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1967-9517. May 23, 1967. Filed May 29, 1964.

In the nuclear reactor proposed, the reactor control is achieved in simple, small-volume construction, and the deterioration in the control ability can be prevented. It consists of a spherical body just below the reactor core; a pipe, running upward from the spherical body through the reactor core; a pipe, running upward and obliquely also from the spherical body through the reactor shield; a (gas) pump and a bypass outside the reactor pressure-vessel—all these are connected in one system. The spherical body and the part of the two pipes which are just outside the spherical body are filled with a liquid containing control poison; all the rest of the space, i.e., in the piping, is filled with a gas. The liquid level in the part of pipe through the reactor core can be raised or lowered for the purpose of reactor control by means of the pump and bypass for the gas. (NSA of Japan)

18646 NUCLEAR REACTOR HEAT TRANSFER SYSTEM. Parris, Harold C. (to United States Atomic Energy Commission). U. S. Patent 3,374,149. Mar. 19, 1968.

A nuclear reactor heat transfer system having a superheater, reheater and evaporator heat exchanging modules, each having a primary liquid metal flow path and a secondary fluid flow path, is described. The primary fluid flow paths of the superheater and reheater modules are connected in parallel with each other and in series with the primary fluid flow path of the evaporator module. The secondary fluid flow paths of the superheater, evaporator and reheater modules are connected in series through a turbine. (AEC)

18647 PLUG FOR SEALING A PRESSURE TUBE. Sasaki, Masayoshi (to Hitachi Ltd.). Japanese Patent 1966-17796. Oct. 11, 1966. Filed Feb. 27, 1964.

The requirements for the plug are usually withstanding the internal pressure and temperature, prevention of the coolant leakage, and easy handling of the plug in connection with the fuel exchange. The proposed plug satisfies these requirements. The pressure tube contains fuel elements, shielding plugs, "orifice" plugs and the entrance and exit for coolant. Coolant flows through the space between the tube wall and the insertions. The plug seals the tube at its ends. It consists of two cylindrical bodies connected to each other. Claws are installed in the holes through the wall of the inner cylindrical body; the claws, when ejected, engage with the grooves cut in the inner surface of the pressure tube for fixing the plug in position. In the other cylindrical body, which connects to the inner one, is the mechanism (including a bar and spring) for operating the claws. The coolant-tightness is achieved at the inner closed end of the inner cylindrical body by means of the internal pressure of coolant. (NSA of Japan)

18648 VOID DETECTOR IN THE REACTOR CORE. Yusa, Hideo (to Hitachi Ltd.). Japanese Patent 1967-12016. July 8, 1967. Filed June 19, 1965.

The insertion of a separate void-detector into the reactor core can be eliminated, and improved measurements of void in both the nuclear and the thermal aspects can be achieved. A nuclear-fuel rod with a cladding of an (electrically) conducting material is filled with a heat-resistant, insulating material; and, through this material along the central axis runs a core wire. The end of this wire protrudes out of the cladding, and on top of this end is attached a point electrode. An insulation is provided between the electrode and the rod cladding. (NSA of Japan)

18649 SAFETY DEVICE FOR A NUCLEAR REACTOR. Aoki, Naoji (to Hitachi Ltd.). Japanese Patent 1967-9516. May 23, 1967. Filed June 18, 1965.

Liquid poison as a back-up reactor control can be injected uniformly into the circulating moderator-coolant to shut down the reactor at any operating condition. Poison-injection pipes are set at many points in the path of circulating moderator-coolant to inject it uniformly; a circulation pump and a heat exchanger are installed in the path. (NSA of Japan)

18650 EMERGENCY ESCAPE DEVICE FOR THE CONTAINMENT VESSEL. Goto, Jiro (to Hitachi Ltd.). Japanese Patent 1967-9515. May 23, 1967. Filed July 14, 1965.

An emergency escape device is proposed which enables the operator to escape out of the containment vessel at the time of a reactor accident. A protruding semispherical chamber is installed at the opening of the containment-vessel wall, the floor being at the floor level of the containment vessel. A vertical chamber extends downwards from this floor; the floor can come down along the walls of the latter chamber by releasing its hook. When it lowers, the "open" floor can be closed automatically by a plate, which is normally in an upright position. In the lower part of the vertical chamber is provided an escape-door which can be tightly shut. (NSA of Japan)

18651 PRESSURE SUPPRESSION TYPE CONTAINMENT VESSEL. Komeno, Jin (to Hitachi Ltd.). Japanese Patent 1967-9513. May 23, 1967. Filed May 4, 1965.

By the method proposed, the peak pressure after a reactor accident can be reduced considerably, thus leading to a reduction of the construction cost. Pressure-suppression chambers are installed near to the bottom of the containment vessel with a pipe connecting the two. Water tanks, which also connect to the containment vessel with a pipe, are installed above the suppression chambers. The tank and the chamber are connected by means of a siphon pipe. In the tank the pipe-end is dipped in the water, and in the chamber the end is equipped with sprays. (NSA of Japan)

18652 METHOD FOR SHUTTING DOWN A REACTOR. Yamanouchi, Hajime (to Hitachi Ltd.). Japanese Patent 1967-12011. July 8, 1967. Filed Feb. 27, 1964.

An improved method is proposed for shutting down a reactor with poison gas. In the reactor core each pressurized pipe containing a fuel rod is surrounded with the outer tube, the space between the two being filled with an insulating gas, CO_2 for example; these spaces around each pipe are connected. For shutting down the reactor, a poison gas having a large neutron-absorption cross-section replaces the insulating gas in the spaces. (NSA of Japan)

18653 STOPPER MECHANISM FOR A REACTOR CONTROL ROD. Akimoto, Seiichi (to Hitachi Ltd.). Japanese Patent 1966-21280. Dec. 12, 1966. Filed Aug. 8, 1964.

The stopper mechanism proposed is used to prevent a control rod from being pulled out beyond its given point. Signals can be given for indicating the set position and for ascertaining the lock completion, and also the motor for moving the control rod can be controlled automatically with a definite indication of the movement. In parallel with the drive rod for a reactor control rod, which has a "contact" protrusion, is installed an "interlocking" rod. This rod actuates, at one end, a switch for the "contact-to-the-stopper" signal, and at the other end, a switch for the "lock-completion" signal. Without the two it is kept at the "not-completed lock" signal position by means of a spring. The normal position is taken by moving the inside part of the stopper (which can be fixed at a given point), and by means of a spring and a snap ring. The protrusion is contacted to a sleeve, locked by the interlocking rod and a bolt. (NSA of Japan)

18654 LIQUID METAL CIRCUIT DEVICE. Eto, Kazuaki (to Hitachi Ltd.). Japanese Patent 1966-20920. Dec. 6, 1966. Filed Oct. 28, 1963.

In the proposed liquid-metal circuit, a shutdown-drain valve which is not heated externally is used. As is usual, liquid metal is circulated through the reactor core, an external heat-exchanger, an expansion-absorbing tank to receive the thermally expanded part of liquid metal, and a recovery tank in which liquid metal is withdrawn. A pipe connects to the recovery tank from the circulation circuit. In this pipe a valve which is partly opened during the reactor operation and thus through which liquid metal flows at a small flow-rate is installed, thereby heating the valve constantly. A pipe runs from the recovery tank to the expansion-absorbing tank. Another pipe runs from the recovery tank to the expansion-absorbing tank for carrying an excess of liquid metal into the latter tank. (NSA of Japan)

18655 SUPPORT STRUCTURE FOR NUCLEAR FUEL ELEMENTS. Mombazet, Rene; Raynaud, Noel (to Commissariat a l'Energie Atomique). U. S. Patent 3,364,122. Priority date Feb. 19, 1965, France.

The description of a fuel element assembly support system is presented. The fuel element is positioned vertically in the longitudinal axis of an annular sleeve comprising a cylindrical bracket which supports the base of the fuel element. At least three discs are uniformly spaced around the axis of the fuel element and engage in a tonic groove formed in the internal surface of the sleeve and in recesses in the cylindrical support bracket. The discs are held in position by the weight of the fuel element exerted on the cylindrical support bracket. (U. S. Pat. Gazette)

18656 NUCLEAR CONTROL ROD ACTUATOR. Winders, Gordon R.; Litt, Kenneth C.; Dossett, John S. (to Babcock and Wilcox Co.). U. S. Patent 3,364,120. Filed Jan. 24, 1966.

The description of a control rod actuator for a control rod of constant diameter is presented. The actuator system consists of a control rod, an elongated cylinder containing the control rod, a fluid-actuated piston with two-position movement, and a coupling system to connect the control rod with the cylinder. The coupling system is arranged so that in the first movement of the piston both the control rod and the cylinder are engaged in the movement. In the second movement of the piston only the cylinder is in motion and the control rod remains stationary. (U. S. Pat. Gazette)

18657 DRIVE FOR A REACTOR CONTROL ROD. Sasaki, Masayoshi (to Hitachi Ltd.). Japanese Patent 1966-16360. Sept. 14, 1966. Filed Sept. 17, 1963.

The proposed drive for a reactor control rod has the following advantages: easy switching of a single control rod from the shim-safety control to the regulating control and vice versa; setting of regulating control on the single (shim-safety) control rod over the whole length and for any given length; and safe and definite stopping of a control rod for both types of reactor control by a mechanical means, even when a failure occurs in the electrical system. It consists of a rod, which moves corresponding to the movement of a control rod; a device for releasing and operating the limitation actuated by the set state of the rod; a device for controlling the regulating drive within the limited length and at a given position of the control rod; a device for detaching the regulating drive control device and the control rod—thus far, the drive for the reactor regulating control; a device for detaching from the control rod; a drive for the shim control—the shim control; and a mechanism for conveying the driving power to the control rod from either of the two systems just described. (NSA of Japan)

18658 TEORIYA I FIZIKA REAKTOROV. (Reactor Physics and Theory). Yurovoi, L. N. Moscow, Atomizdat, 1967. 132p.

A collection of fifteen articles is presented on reactor physics and calculational tchniques. The aspects of high-order perturbation theory for resolving certain problems in reactor calculations and protection are discussed in the first article. The second article offers the analytical solution for multizonal criticality problems using Carlson S_n approximation method. The conditional separation of the spatial and angular variables in neutron transport in the spherical and cylindrical geometry problems, the algorithm and program of the non-diffusion multigroup calculations of neutron field in laminar plane-parallel systems are covered in the third and fourth articles. The flux distribution and the rate of various processes in the heterogeneous fast reactor cell, analytical method for large heterogeneous reactor calculations with P_1 multigroup approximation, and the analytical method for plane shielding calculation using multigroup P_n approximation are given in the following three articles. Wave methods for determining the dimensions of the two-zone systems, and calculational methods for albedo semispace are suggested in articles eight and nine. The aspects of simulating critical neutron distribution in subcritical systems, the influence of neutron absorption by the source on the neutron age in the fission spectra in water, and the stability of solutions for non-linear non-stationary reactor equations are discussed in articles ten, eleven, and twelve. The last three articles cover data on neutron field time-dependence during pulsed neutron source operation, the non-stationary processes induced in the nuclear reactor with circulating compressed media by dissociation of the circuit and dynamics of each of its elements, and the experimental studies of thermal neutron diffusion in light and heavy water. References are given for each article. (R.V.J.)

18659 LONG-RANGE PROGRAM FOR THE DEVELOPMENT AND UTILIZATION OF ATOMIC ENERGY. DESCRIPTION AND EXPLANATION, AND DATA. Tokyo, Japan, Atomic Energy Bureau, 1968. 408p. (In Japanese).

Topics discussed in the book include the Long-range Program for the Development and Utilization of Atomic Energy; description of the aspects of the Long-range Program; explanation of the aspects, with data; and, the Appendix. The nature and history of the Long-range Program, the background (and course to) behind the present revision, and an outline of the revised Long-range Program are given. The Long-range Program includes the following: nuclear power generation, development of power reactors, nuclear fuels, nuclear-powered ships, utilization of radiations, nuclear fusion, safety countermeasures, basic researches, and training and education. (NSA of Japan)

GENERAL

18660 (COO-1585-3) RESEARCH ON ATMOSPHERIC TURBULENCE AND DIFFUSION. Technical Progress Report, May 1–December 31, 1967. Kao, S. K. (Utah Univ., Salt Lake City. Dept. of Meteorology). Jan. 1968. Contract AT(11-1)-1585. 6p. Dep. CFSTI.

Research on atmospheric turbulence and diffusion was continued. A mathematical analysis was made of the kinematics and dynamics of the relative dispersion of particles in a stratified, rotating atmosphere. Characteristics of the large-scale diffusion process at various levels in the troposphere (200, 500, and 800 mb) were investigated. Characteristics of relative particle dispersion in the atmosphere's boundary layer were studied. A preliminary analysis of the interaction of the large-scale atmospheric turbulence was conducted. The turbulence and energy variation in the upper atmosphere were examined using rocket data for the years 1963 through 1965. (L.C.L.)

18661 (NVO-99-31) STRUCTURAL DYNAMICS OF CANTILEVER-TYPE BUILDINGS. Blume, John A. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Jan. 1968. Contract AT(26-1)-99. 48p. (CONF-690101-1). Dep. CFSTI.

For Presentation at 4th World Conference on Earthquake Engineering, Santiago, Chile.

Structural and dynamic properties of buildings vary with the ratio of the stiffness of the horizontal to the vertical members and elements. Many contemporary buildings have low ratios, and perform more as cantilevers than as frames. Cantilever-type buildings were investigated by the detailed analysis of over forty models covering the entire range of relative stiffnesses. A Modified Cantilever Method is proposed to determine rapidly the natural periods of buildings having little moment restraint from the floor systems. Useful concepts and structural-dynamic data are provided for cantilever-type buildings, which type has been subject to severe earthquake damage in Chile, Anchorage and Caracas. (auth)

18662 (ORO-3556-11) ANNUAL REPORT, II, MYCOLOGICAL INVESTIGATIONS IN ICELAND. Johnson, T. W. Jr. (Duke Univ., Durham, N. C. Dept. of Botany). [1967]. Contract AT(40-1)-3556. 8p. Dep. CFSTI.

Fungi were collected from coastal water, inland streams, lakes and soils of Iceland. Methods of collecting from various habitats are described, and genera of Ascomycetes, Deuteromycetes, and Phycomycetes collected in various habitats are listed. Studies on taxonomy, development, and life cycles are in progress. In addition to mycological studies, other investigations are in progress on terrestrial invertebrates, bird populations, marine algae, vascular plants, and lichens. (H.L.W.)

18663 (SC-CR-67-2749) COMPUTATION OF EQUILIBRIUM HYPERSONIC FLOW ABOUT BLUNT AXISYMMETRIC BODIES WITH SHARP CORNERS. Final Report. Curtis, J. T.; Strom, C. R. (Cornell Aeronautical Lab., Inc., Buffalo, N. Y.). Aug. 1967. Contract AT(29-1)-789; Subcontract 4804. 134p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

Certain modifications and extensions to the unified, nonequilibrium chemistry, blunt-body flow field program, which has been developed at Cornell Aeronautical Laboratory during the past several years, are presented. These modifications consist of the inclusion of an equilibrium chemistry option and routines for handling embedded shocks and expansion fans originating from sharp corners on the afterbody of a two-dimensional or axisymmetric shape. The gas dynamic analysis required to treat these special problems as well as the details of the coding for the computer are described. (auth)

18664 (SC-DC-67-1951) ONE-DEGREE-OF-FREEDOM AUTOROTATION CHARACTERISTICS OF FLAT PLATES AT LOW SUBSONIC SPEEDS. Stone, George W. (Sandia Corp., Albuquerque, N. Mex.). July 1967. Contract AT(29-1)-789. 10p. (CONF-680101-1). Dep. CFSTI.

From AIAA 6th Aerospace Sciences Meeting, New York.

In order to understand and analyze the free flight dynamics of flat plates, a subsonic, one-degree-of-freedom wind tunnel test was conducted to determine the dynamic stability characteristics of typical flat plate models. The wind tunnel models consisted of three rectangular flat plates and one circular disc pinned to supports so that each model was free to tumble on precision ball bearings about an axis through its center of gravity. The wind tunnel conditions included sea level density, air speeds from 23 to 45 mph, and a 90° angle of attack. The tests showed that these configurations would autorotate when constrained about one axis; that the rate of autorotation increased linearly with velocity over the range of air speed used; and that the dynamic stability characteristics of flat plates are highly nonlinear with the square of the reduced frequency. A new technique was developed for calculating dynamic stability derivatives from the total angular energy of the system. (L.C.L.)

18665 (SC-RR-66-2682) UNIVALVE: A COMPUTER CODE FOR ANALYZING DYNAMIC LARGE DEFLECTION ELASTIC-PLASTIC RESPONSE OF BEAMS AND RINGS. Krieg, R. D.; Key, S. W. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1968. Contract AT(29-1)-789. 154p. Dep. CFSTI.

UNIVALVE is a FORTRAN code which computes the dynamic response of beams and rings of arbitrary plane configuration whose motion is two-dimensional. The beam material may be elastic-plastic, strain hardening, and strain rate sensitive. Arbitrarily large deflections are allowed. It may be acted upon by time and space dependent loads, initial velocities, and initial stresses. Many combinations of boundary conditions are handled. The final equilibrium shape is also found. The report contains derivations of the differential equations. The method of solving these by finite differencing in time and space is presented in detail. Flow charts, program listings, and input instructions are included. Sample calculations are presented and compared with theoretical results. (auth)

18666 (SC-RR-67-778) AUTOROTATIONAL CHARACTERISTICS OF FLAT PLATES AND RIGHT CIRCULAR CYLINDERS AT SUBSONIC SPEEDS. Bustamante, A. C.; Stone, G. W. Jr. (Sandia Lab., Albuquerque, N. Mex.). Nov. 1967. 27p. (CONF-670962-1). Dep. CFSTI.

From Conference on Dynamics and Aerodynamics of Bomblets, Eglin Air Force Base, Fla.

Studies were conducted to investigate the free-flight motion of flat plates and right circular cylinders at subsonic speeds. For these studies, a new technique was developed for calculating dynamic stability derivatives. (auth)

18667 (SC-RR-67-810) MOLDED RIGID URETHANE FOAMS. I. DIMENSIONAL CHARACTERISTICS. Hermansen, Ralph D. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1968. Contract AT(29-1)-789. 43p. Dep. CFSTI.

The weight change and dimensional change of 6 × 6 × 1 inch molded foam blocks conditioned in a controlled, low-humidity chamber for a period of 60 days is described. Three urethane foam systems having distinctly different chemical structures were used to mold the foam blocks. The effect of varied processing conditions on the dimensional characteristics of the blocks was studied for mold preheat temperatures of 75°, 130°, and 180°F and for cure schedules of 8 and 16 hours at 325°F. The weight and dimensional changes predicted from gaseous diffusion are compared to the actual results. (auth)

18668 (SC-RR-67-848) LARGE DEFLECTION DYNAMIC ELASTIC–PLASTIC RESPONSE OF CLAMPED BEAMS SUBJECTED TO EXPLOSIVE LOADING. Krieg, R. D.; Duffey, T. A. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1968. Contract AT(29-1)-789. 78p. Dep. CFSTI.

DuPont EL506D sheet explosive was used to load the center 2 inches of 10-inch-long clamped beams. The beams were made of 1022 steel and 6061-T6 aluminum. A streak camera and high-speed framing camera were used to record the motion of the beams. Strain gages recorded surface strains at several locations on each beam. All beams experienced plastic strains in the large deflection region. (auth)

18669 (SC-TM-67-3025) RESPONSE OF AN ELASTIC, INFINITE, CYLINDRICAL SHELL TO INITIAL MEMBRANE AND BENDING STRESSES. Murfin, Walter B. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1968. Contract AT(29-1)-789. 17p. Dep. CFSTI.

A modal solution is developed for coupled membrane and bending stresses in a cylindrical shell with initial stress distribution. It is shown that coupling is relatively unimportant. It is also shown that conduction is of little importance when the initial stresses result from initial temperatures. (auth)

18670 (TID-5059(8th Rev.)) CORPORATE AUTHOR HEADINGS USED BY THE U. S. ATOMIC ENERGY COMMISSION IN CATALOGING REPORTS. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Jan. 1968. 160p. Dep. CFSTI.

18671 (UCD-472-212) USE OF MINIATURE SWINE IN GERONTOLOGIC RESEARCH. Bustad, Leo K.; Rosenblatt, L. S. (California Univ., Davis. Radiobiology Lab.); Palotay, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contracts AT(04-3)-472; AT(45-1)-1830. 38p. (CONF-671124-1). DTIE.

From Symposium on the Laboratory Animal in Gerontologic Research, St. Petersburg, Fla.

Criteria for selecting a species for long-term studies are as follows: a well-defined life span; resistance to epidemics of disease that cause high mortality or morbidity and that are not readily controlled; physiological systems and disease entities resembling those of man; dietary regimen or nutritional requirements resembling those of man; a favorable karyotype and firm information on stem cell populations and immune complement systems; readily housed and economical to maintain; and something unique in the species of value in gerontological studies. These factors are discussed as they apply to miniature swine. (H.L.W.)

18672 (UCID-15266) 100,000 PSI PULSE PRESSURE SOURCE FOR TRANSDUCER EVALUATION. Status Report. Field, John E. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 6, 1966. Contract W-7405-eng-48. 6p. Dep. CFSTI.

A technique for increasing the range of capability of a pulse pressure source for transducer evaluation to over 100,000 psi with retention of very low input pressures is described. An air gun using a reservoir of low pressure air propels a primary mass through a tube to a secondary mass installed in the tube. A volume of air from the edge of the tube vent to the face of the secondary mass is compressed and becomes the source pressure used in evaluating the response characteristics of a transducer. (F.S.)

18673 (UCID-15273) SOME RANDOM THOUGHTS ON NEAR-SATURATION LIQUID THERMODYNAMICS. Stubbs, T. F. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 13, 1966. Contract W-7405-eng-48. 20p. Dep. CFSTI.

Analyses of specific heat at constant pressure and thermodynamic state functions including density, enthalpy, entropy, Gibbs free energy, Helmholtz free energy, internal energy, pressures, and temperatures were made. It is shown that isothermal compressibility for a near saturated liquid can be found if the coefficient of thermal expansion, specific heat, sound velocity, and temperature can be measured. (F.S.)

18674 (UCRL-70600) A MONTE CARLO SOLUTION TO THE PROBLEM OF TORSION OF PRISMATIC BARS. Carr, R. B. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 7, 1967. Contract W-7405-eng-48. 12p. (CONF-680201-). Dep. CFSTI.

From 4th Southeastern Conference on Theoretical and Applied Mechanics, New Orleans, La.

The application of a Monte Carlo technique to the problem of torsion of a constant cross-section bar of arbitrary shape is described. The use of this method demonstrates the procedure of solving a class of solid mechanics problems by a numerical technique that requires no prior zoning of the shape being investigated, and also obtains the shear stress at a single point without solving for the total stress distribution. It is shown that obtaining the derivative of a stress function that satisfies Laplace's equation converges to within 5 percent of the analytical solution for shear stress near a semicircular notch in a circular shaft by only using 20,000 random walks for the stress function. (auth)

18675 (UCRL-70870) BASIC ACCURACY EVALUATION OF PRECISION N/C DRAFTING MACHINES. Spies, R. J.; Bryan, J. B. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 15, 1968. Contract W-7405-eng-48. 13p. (CONF-680109-1). Dep. CFSTI.

From Meeting of Precision Plotter Users Association, Los Angeles, Calif.

N/C drafting machines are required to draw clean and accurately positioned lines. A description is given of the test equipment and procedures which were used to evaluate the overall machine and individual components of the machine in terms of the accuracy of the drawings obtained. (L.C.L.)

18676 (AEC-tr-6869/2) UKRAINIAN PHYSICS JOURNAL. Translation of Ukr. Fiz. Zh., 12: 177-354(1967). 184p. (TT-67-51421/2; IPST-Cat.-5062). CFSTI.

Separate abstracts were prepared for 2 papers. (M.C.G.)

For abstracts of individual papers see: 16506 and 18318.

18677 (ANL-Trans-576) ASYMPTOTIC SOLUTION OF EQUATIONS OF INCOMPRESSIBLE BOUNDARY LAYERS WITH A NEGATIVE PRESSURE GRADIENT AT STRONG INJECTIONS. Filimonov, V. N. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 5, 48-52(1967). 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

During the entrance of bodies into the terrestrial atmosphere at high velocities the entrainment of the mass from the surface of the body caused by high convective and mainly by radiative currents can assume arbitrarily high values, i.e., the injection into the boundary layer can trend toward infinity. The solution of Prandtl equations for incompressible boundary layers with a negative pressure gradient ($dp/dx < 0$) at strong injections is presented. The asymptotic solution obtained conforms with the exact numerical solution for such magnitudes of the injection where the approximation of the boundary layer is still applicable. A similar solution for automodel equations in the vicinity of the critical point has been obtained earlier. The application of the asymptotic solution permitted the determination of an expression for the friction coefficient which is convenient for concrete calculations in the case of arbitrary negative pressure gradients. (auth)

18678 (LA-tr-67-114) IRON DEFICIENCY AND GRANULOCYTE DIAMETERS. Mannheimer, E.; Vetter, H. Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from Wien. Z. Inn. Med. Grenzgeb., 34: 339-41(1953). 6p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The diameters of erythrocytes and granulocytes in five cases of human iron deficiency anemia were measured using a micrometer with an oil immersion objective. With this method the smallest determinable difference between two cells was 0.7μ. The mean values were obtained by measuring the diameter of 200 erythrocytes and 100 granulocytes. The diagnosis of iron deficiency anemia was made from the peripheral blood picture, the bone marrow puncture, and the level of the serum iron. The iron deficiency was corrected by intravenous injection of colloidal iron. The tabulated results showed that in the five cases of anemia the mean diameters of the erythrocytes and granulocytes were significantly smaller than normal. Following treatment of the iron deficiency with colloidal iron the diameters approached the normal values. (H.L.W.)

18679 (ORNL-tr-1792) MOISTURE EXPANSION OF CONCRETE. Pilny, Franz. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Zem. Beton, No. 30, 1-9 (1964). 20p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The effect of moisture on the expansion behavior of structural concrete was investigated. This moisture includes both the water content of the concrete and the relative humidity of the environment in which the concrete is used. Numerous references are made to previous experimental studies on the subject. Laboratory tests were made at different moisture and temperature conditions to determine the moisture expansion of concrete. Field experiments were conducted on reinforced concrete runway slabs. It is concluded that, while thermal expansion coefficients for interior structural concrete can be assigned which will adequately compensate for the effects of both moisture and thermal expansion, the deformation behavior of concrete construction which is exposed to the weather should be evaluated by considering the contribution of both temperature and moisture to this deformation. (L.C.L.)

18680 SCIENTIFIC PROGRESS AND HUMAN VALUES. Proceedings of the Conference Celebrating the 75th Anniversary of the California Inst. of Tech., Pasadena, Calif., October 25-27, 1966. Hutchings, Edward; Hutchings, Elizabeth (eds.). New York, American Elsevier Publishing Co., Inc., 1967. 219p. $7.50. (CONF-661058).

Included are 15 papers on the various ways in which science and technology serve mankind and the ways in which scientists and engineers can aid social scientists to bring the question of human values in a modern civilization into better perspective. Separate abstracts were prepared for 3 papers. (H.D.R.)

For abstracts of individual papers see: 17308, 17884, and 18477.

18681 ANNUAL REPORT TO CONGRESS OF THE ATOMIC ENERGY COMMISSION FOR 1967. Washington, D. C., Atomic Energy Commission, 1968. 409p. GPO.

Highlights of the United States Atomic Energy Program in 1967 are presented. Separate chapters are included for activities in the development of: source and special nuclear materials, safeguards and materials management, the nuclear defense effort, naval propulsion reactors, reactor development and technology, licensing and regulation, operational safety, nuclear rocket propulsion, specialized nuclear power units, isotopic radiation applications, the Plowshare Program, international cooperation, information services, nuclear education and training, basic research, industrial participation, and administration and management. (H.D.R.)

18682 SOVETSKAYA ATOMNAYA NAUKA I TEKHNIKA. (Soviet Atomic Sciences and Technology). Shchelkin, K. I. (ed.). Moscow, Atomizdat, 1967. 392p.

The Soviet achievements in nuclear science and technology are reviewed. Descriptions are given of the first nuclear reactor, experimental reactors, nuclear power plants, and nuclear icebreaker "Lenin." Studies of charged particle accelerators, high-energy physics, 70 GeV proton synchrotron, and the heavy ion accelerator are discussed, as well as the synthesis of transuranium elements and controlled thermonuclear reactions. Nuclear fuel technology and radiochemistry are examined. Nuclear emission in sciences and agriculture is reviewed, considering nuclear instrumentation and atomic energy in biology and medicine. Radiation safety and international cooperation are also covered. (R.V.J.)

Appendix I

JOURNAL LIST

The following list includes 1968 additions to the comprehensive list published in NSA, Volume 22, No. 1, January 15, 1968. In the future, comprehensive lists will be published once each year (in January), and current additions will be cumulated on a monthly basis (in alternate issues) until the next comprehensive list is issued.

The title abbreviations are based on the United States of America Standards Institute's REVISED AND ENLARGED WORD-ABBREVIATION LIST FOR USASI Z39.5–1963 AMERICAN STANDARD FOR PERIODICAL TITLE ABBREVIATIONS. Titles of journals that are scanned regularly for NUCLEAR SCIENCE ABSTRACTS are marked by an asterisk (*). Foreign-language journals identified by a dagger (†) are available in English translation. The original-language title for a translated journal is given in parenthesis after the English title.

Acta Anat. Nippon.
Acta Anatomica Nipponica
see Kaibogaku Zasshi
Acta Astron.
Acta Astronomica, Polska Akademia Nauk (formed by merger of Acta Astronomica, Ser. A; Ser. B; and Ser. C) *(Poland)*
Acta Entomol. Bohemoslov.
Acta Entomologica Bohemoslovaca *(Czechoslovakia)*
Acta Med. Iugoslav.
Acta Medica Iugoslavica *(Yugoslavia)*
Acta Pharm. Hung.
Acta Pharmaceutica Hungarica *(Hungary)*
Acta Phys. Chem.
*Acta Physica et Chemica *(Hungary)*
Acta Polytech., Chem. Met. Ser.
Acta Polytechnica, Chemistry including Metallurgy Series *(Sweden)*
Acta Sci. Natur. Univ. Pekin.
Acta Scientiarum Naturalium Universitatis Pekinensis
see Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Acta Univ. Nankinensis Sci. Natur.
Acta Universitatis Nankinensis Scientiarum Naturalium
see Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Advan. Contr. Syst.
Advances in Control Systems *(U. S.)*
Advan. Cryog. Eng.
Advances in Cryogenic Engineering *(U. S.)*
Advan. Nucl. Phys.
Advances in Nuclear Physics *(U. S.)*
Advan. X-Ray Anal.
Advances in X-Ray Analysis *(U. S.)*
Agr. Hokkaido
Agriculture in Hokkaido
see Hokuno
Agr. Res. (New Delhi)
Agricultural Research (New Delhi) *(India)*
Air Water Pollut.
*Air and Water Pollution (formerly International Journal of Air Water Pollution) *(U. S.–England)*
Ala. J. Med. Sci.
Alabama Journal of Medical Sciences, The *(U. S.)*
Ann. Bot. Fenn.
Annales Botanici Fennici *(Finland)*
Ann. Ponts Chaussees
Annales des Ponts et Chaussees *(France)*
Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Geol.
*Annales Universitatis Scientiarum Budapestinensis de Rolando Eotvos Nominatae, Sectio Geologica *(Hungary)*
An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz.
Analele Universitatii Bucuresti, Seria Stiintele Naturii, Fizica *(Romania)*
Arbeitsgemeinsch. Forsch. Landes Nordrhein-Westfalen
Arbeitsgemeinschaft fuer Forschung des Landes Nordrhein-Westfalen *(West Germany)*
Arbeitsmed.-Sozialmed.-Arbeitshyg.
Arbeitsmedizin-Sozialmedizin-Arbeitshygiene *(West Germany)*
Arch. Jap. Chir.
Archiv fuer Japanische Chirurgie
see Nippon Geka Hokan
Arch. Neer. Sci. Exactes Natur.
Archives Neerlandaises des Sciences Exactes et Naturelles *(Netherlands)*
ASM (Amer. Soc. Metals), Trans. Quart.
*ASM (American Society for Metals), Transactions Quarterly (formerly Transactions of the American Society for Metals) *(U. S.)*
Astrofizika
Astrofizika *(Armenian S.S.R.)*
Astrophys. Lett.
*Astrophysical Letters *(Scotland)* *
At. Absorption Newslett.
Atomic Absorption Newsletter *(U. S.)*
At. Energy (China)
Atomic Energy (China)
see Yuan Tzu Neng
At. Energy Law J.
Atomic Energy Law Journal *(U. S.)*
Australas. Mfr.
Australasian Manufacturer *(Australia)*
Automat. Electron.
Automatica si Electronica *(Romania)*
Bautechnik
Bautechnik, Die *(West Germany)*
Ber. Deut. Ges. Geol. Wiss., Reihe B
Berichte der Deutschen Gesellschaft fuer Geologische Wissenschaften, Reihe B. Mineralogie und Lagerstaettenforschung *(East Germany)*
Berg- Huettenmaenn. Monatsh. Montan. Hochsch. Leoben
Berg- und Huettenmaennische Monatschefte der Montanistischen Hochschule in Leoben *(West Germany)*
Berlin. Wetterkarte, Suppl.
Berliner Wetterkarte, Supplement *(West Germany)*
Blech
Blech *(West Germany)*
Bodenkultur
Bodenkultur, Die *(Austria)*
Boll. Zool.
Bollettino di Zoologia. Pubblicato dall'Unione Zoologica Italiana *(Italy)*
Bol. Univ. Fed. Parana, Fis. Teor.
*Boletim da Universidade Federal do Parana, Fisica Teorica *(Brazil)*
Brit. Food J.
British Food Journal *(England)*
Brit. Plast.
British Plastics *(England)*
Bull. Astron.
Bulletin Astronomique *(France)*
Bull. Belgicatom
Bulletin Belgicatom (formerly Belgicatom, Association Belge pour le Developpement Paficique de l'Energie Atomique, Bulletin d'Information) *(Belgium)*
Bull. Calcutta Math. Soc.
Bulletin of the Calcutta Mathematical Society *(India)*

Bull. Fac. Eng., Hiroshima Univ.
Bulletin of the Faculty of Engineering, Hiroshima University
see Hiroshima Daigaku Kogakubu Kenkyu Hokoku
Bull. Fac. Sci. Eng., Chuo Univ.
Bulletin of the Faculty of Science and Engineering, Chuo University
see Chuo Daigaku Rikogakubu Kiyo
Bull. Inst. Geophys., Nat. Cent. Univ.
*Bulletin of the Institute of Geophysics, National Central University *(China (Taiwan))*
Bull. Inst. Int. Froid, Annexe
Bulletin de l'Institut International du Froid, Annexe *(France)*
Bull. Inst. Space Aeronaut. Sci., Univ. Tokyo
Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo
see Tokyo Daigaku Uchu Koku Kenkyusho Hokoku
Bull Int. Inst. Refrig., Suppl.
Bulletin of the International Institute of Refrigeration, Supplement
see Bull. Inst. Int. Froid, Annexe
Bull. Kyoto Educ. Univ., Ser. B
Bulletin of the Kyoto Educational University, Series B. Mathematics and Natural Science *(Japan)*
Bull. Res. Inst. Miner. Dressing Met., Tohoku Univ.
Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University
see Tohoku Daigaku Senko Seiren Kenkyusho Iho
Bull. Soc. Roy. Bot. Belg.
Bulletin de la Societe Royale de Botanique ds Belgique *(Belgium)*
Bus. Week
Business Week *(U. S.)*
Cah. Ing. Agron.
Cahiers des Ingenieurs Agronomes *(France)*
Calcified Tissue Res.
Calcified Tissue Research *(West Germany)*
Can. J. Psychol.
Canadian Journal of Psychology *(Canada)*
Can. Mach. Metalwork.
Canadian Machinery and Metalworking *(Canada)*
Canner/Packer
Canner/Packer *(U. S.)*
Can. Nurse
Canadian Nurse *(Canada)*
Cercet. Met.
Cercetari Metalurgice *(Romania)*
Chesapeake Sci.
Chesapeake Science *(U. S.)*
Chim. Ind., Genie Chim.
Chimie et Industrie, Genie Chimique (formed by the merger of Chimie et Industrie (Paris) and Genie Chimique (Paris)) *(France)*
Chin. Anim. Husb. Vet. Med.
Chinese Animal Husbandry and Veterinary Medicine
see Chung Kuo Hsu Mu Shou I
Chin. J. Surg.
Chinese Journal of Surgery
see Chung Hua Wai K'o Tsa Chih
Chung Hua I Hsueh Tsa Chih
Chung Hua I Hsueh Tsa Chih (National Medical Journal of China) *(China)*
Chung Hua Wai K'o Tsa Chih
Chung Hua Wai K'o Tsa Chih (Chinese Journal of Surgery) *(China)*
Chung Kuo Hsu Mu Shou I
Chung Kuo Hsu Mu Shou I (Chinese Animal Husbandry and Veterinary Medicine) *(China)*
Chuo Daigaku Rikogakubu Kiyo
Chuo Daigaku Rikogakubu Kiyo (Bulletin of the Faculty of Science and Engineering, Chuo University) *(Japan)*
Civil Eng. (N. Y.)
Civil Engineering (New York) *(U. S.)*
Coal Age
Coal Age *(U. S.)*
Cobalt
Cobalt *(France)*
Colloq. Int. Cent. Nat. Rech. Sci.
Colloques Internationaux du Centre National de la Recherche Scientifique *(France)*
Commer. Fish. Rev.
Commercial Fisheries Review *(U. S.)*
Comput. Biomed. Res.
Computers and Biomedical Research *(U. S.)*
Concrete J.
Concrete Journal
see Konkurito Janaru
Coord. Chem. Rev.
Coordination Chemistry Reviews *(Netherlands)*
Cuivre, Laitons, Alliages
Cuivre, Laitons, Alliages *(France)*
Curr. Mod. Biol.
Currents in Modern Biology *(Netherlands)*
Czas. Stomatol.
Czasopismo Stomatologiczne *(Poland)*
Denki Shikenjo Kenkyu Hokoku
Denki Shikenjo Kenkyu Hokoku (Researches of the Electrotechnical Laboratory) *(Japan)*
Desalination
Desalination *(Netherlands)*
Diffus. Data
*Diffusion Data *(U. S.)*
Eiyo To Shokuryo
Eiyo To Shokuryo (Journal of Japanese Society of Food and Nutrition) *(Japan)*
Electron. Ind. (Paris).
Electronique Industrielle (Paris) *(France)*
Electron. Packag. Prod.
Electronic Packaging and Production *(U. S.)*
Elec. World
Electrical World *(U. S.)*
Elec. World (Shanghai)
Electrical World (Shanghai)
see Tien Shih Chieh
Elektromedizin
Elektromedizin und Ihre Grezgebiete *(Germany)*
Elektron. Bol'shikh Moshch.
Elektronika Bol'shikh Moshchnostei *(U.S.S.R.)*
Elektrotech. Cas.
Elektrotechnicky Casopis *(Czechoslovakia)*
Elektrotekhnika
Elektrotekhnika *(U.S.S.R.)*
Elektr. Sta.
Elektricheskie Stantsii *(U.S.S.R.)*
Engei Gakkai Zasshi
Engei Gakkai Zasshi (Journal of the Japanese Society for Horticultural Science) *(Japan)*
Engl. Elec. J.
English Electric Journal *(England)*
Entropie
Entropie *(France)*
Ergonomics
Ergonomics *(England)*
Farm, Ranch, Home Quart.
Farm, Ranch and Home Quarterly *(U. S.)*
FDA (Food Drug Admin.) Pap.
FDA (Food and Drug Administration) Papers *(U. S.)*
Fiz. Chastits Vys. Energ., Akad. Nauk Gruz. SSSR, Inst. Fiz.
Fizika Chastits Vysokikh Energii, Akademiya Nauk Gruzinskoi SSR, Institut Fiziki *(Georgian S.S.R.)*
Fiziol. Norm. Patol. (Bucharest)
Fiziologia Normala si Patologica (Bucharest) *(Romania)*
Fiz. Khim. Obrab. Mater.
Fizika i Khimiya Obrabotki Materialov *(U.S.S.R.)*
Fiz. Tekh. Poluprov.
*Fizika i Tekhnika Poluprovodnikov *(U.S.S.R.)*
Flame Notes, Beckman
Flame Notes, Beckman *(U. S.)*
FOA (Forsvarets Forsk.) Rep.
*FOA (Forsvarets Forskningsanstalt) Reports *(Sweden)*
Folia Haematol. (Leipzig)
Folia Haematologia (Leipzig) *(East Germany)*
Folia Med. Cracov.
Folia Medica Cracoviensia *(Poland)*
Forest. Abstr.
Forestry Abstracts *(England)*
Fortschr. Zool.
Fortschritte de Zoologie *(West Germany)*
Foundry
Foundry *(U. S.)*
Freiberg. Forschungsh., B
Freiberger Forschungshefte, Reihe B *(East Germany)*
Fukuoka Acta Med.
Fukuoka Acta Medica
see Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi (Fukuoka Acta Medica) *(Japan)*
Fukushima Daigaku Gakugei Gakubu Rika Hokoku
Fukushima Daigaku Gakugei Gakubu Rika Hokoku (The Science Reports of the Faculty of Arts and Science, Fukushima University) *(Japan)*
Genet. Pol.
*Genetica Polonica *(Poland)*

Geofiz. Byull.
Geofizicheskii Byulleten *(U.S.S.R.)*

Geofys. Sb.
Geofysikalni Sbornik *(Czechoslovakia)*

Geol. Geofiz.
Geologiya i Geofizika *(U.S.S.R.)*

Gidroaeromekhanika
Gidroaeromekhanika *(Ukrainian S.S.R.)*

Haikan Gijutsu
Haikan Gijutsu (The Piping Engineering) *(Japan)*

Handb. Med. Radiol.
Handbuch der Medizinschen Radiologie *(West Germany)*

Harper Hosp. Bull.
Harper Hospital Bulletin *(U. S.)*

Health Lab. Sci.
Health Laboratory Science *(U. S.)*

Heidelberg. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber.
Heidelberger Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Klasse, Sitzungsberichte *(West Germany)*

Hemel Dampkring
Hemel en Dampkring *(Belgium)*

Hiroshima Daigaku Kogakubu Kenkyu Hokoku
Hiroshima Daigaku Kogakubu Kenkyu Hokoku (Bulletin of the Faculty of Engineering, Hiroshima University) *(Japan)*

Hoken Butsuri
Hoken Butsuri (Journal of Japan Health Physics Society) *(Japan)*

Hokuno
Hokuno (Agriculture in Hokkaido) *(Japan)*

Honvedorvos
Honvedorvos *(Hungary)*

Hyogo Noka Daigaku Kiyo
Hyogo Noka Daigaku Kiyo (Memoirs of the Hyogo University of Agriculture) *(Japan)*

Idengaku Zasshi, Suppl.
Idengaku Zasshi, Supplement (Japanese Journal of Genetics, Supplement) *(Japan)*

Ind.-Anz.
Industrie-Anzeiger *(West Germany)*

Ind.-Elektron. Forsch. Fertigung
Industrie-Elektronik in Forschung und Fertigung *(West Germany)*

Indian J. Agr. Sci.
Indian Journal of Agricultural Science, The *(India)*

Indian J. Appl. Chem.
Indian Journal of Applied Chemistry *(India)*

Indian J. Cancer
Indian Journal of Cancer *(India)*

Indian J. Occup. Health
Indian Journal of Occupational Health *(India)*

Ind. Water Eng.
Industrial Water Engineering *(U. S.)*

Inform. Byull. Sov. Antarkt. Eksped.
Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii *(U.S.S.R.)*

Inst. Mining Met., Trans./Sect. B
Institution of Mining and Metallurgy, Transactions/Section B. Applied Earth Science (continues in part Transactions of the Institution of Mining and Metallurgy) *(England)*

Inst. Petrol. Rev.
Institute of Petroleum Review, The *(England)*

Int. Ass. Sci. Hydrol., Bull.
International Association of Scientific Hydrology, Bulletin *(Belgium)*

Int. Chem. Eng.
*International Chemical Engineering. A Quarterly Journal of Translations from Russia, Eastern Europe, and Asia *(U. S.)*

Int. J. Neurol.
International Journal of Neurology *(U. S.)*

Int. Rev. Gesam. Hydrobiol.
Internationale Revue der Gesamten Hydrobiologie *(East Germany)*

Int. Surg.
International Surgery *(U. S.)*

Inzh. Zh., Mekh. Tverd. Tela
Inzhenernyi Zhurnal, Mekhanika Tverdogo Tela (formerly Inzhenernyi Zhurnal) *(U.S.S.R.)*

Iron Age Metalwork. Int.
Iron Age Metalworking International *(U. S.)*

Izobret., Prom. Obraztsy, Tovarnye Znaki
Izobreteniya, Promyshlennye Obraztsy, Tovarnye Znaki *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Geol.
Izvestiya Akademii Nauk SSSR, Seriya Geologicheskaya *(U.S.S.R.)*

Izv. Vyssh. Ucheb. Zaved., Priborostr.
Izvestiya Vysshikh Uchebnykh Zavedenii, Priborostroenie *(U.S.S.R.)*

Jap. J. Dairy Sci.
Japanese Journal of Dairy Science (Japan)
see *Rakuno Kagaku no Kenkyu*

Jap. J. Genet., Suppl.
Japanese Journal of Genetics, Supplement
see *Idengaku Zasshi, Suppl.*

Jap. J. Pharm. Chem.
Japanese Journal of Pharmacy and Chemistry
see *Yakugaku Kenkyu*

Jap. J. Zootech. Sci.
Japanese Journal of Zootechnical Science
see *Nippon Chikusangaku Kaiho*

JARE Sci. Rep., Spec. Issue
JARE Scientific Reports, Special Issue *(Japan)*

J. Aust. Ceram. Soc.
Journal of the Australian Ceramic Society *(Australia)*

J. Balneol. Soc. Jap.
Journal of the Balneological Society of Japan
see *Onsen Kagaku*

J. Belge Radiol., Monogr.
*Journal Belge de Radiologie, Monographie *(Belgium)*

Jeune Sci.
Jeune Scientifique *(Canada)*

J. Forensic Med.
Journal of Forensic Medicine *(South Africa)*

J. Geol.
Journal of Geology *(U. S.)*

Jibiinkoka Rinsho
Jibiinkoka Rinsho (Oto-Rhino-Laryngological Clinic) *(Japan)*

J. Indian Soc. Soil Sci.
Journal of the Indian Society of Soil Science *(India)*

J. Inst. Safety High Pressure Gas Eng.
Journal of the Inst. of Safety of High Pressure Gas Engineering
see *Koatsu Gasu*

J. Inst. Telecommun. Eng.
Journal of the Institution of Telecommunication Engineers *(India)*

J. Irrig. Drain. Div., Amer. Soc. Civil Eng.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers *(U. S.)*

J. Jap. Health Phys. Soc.
Journal of Japan Health Physics Society
see *Hoken Butsuri*

J. Jap. Soc. Food Nutr.
Journal of Japanese Society of Food and Nutrition
see *Eiyo To Shokuryo*

J. Jap. Soc. Hort. Sci.
Journal of the Japanese Society for Horticultural Science
see *Engei Gakkai Zasshi*

J. Jap. Stomatol. Soc.
Journal of the Japan Stomatological Society, The
see *Kokubyo Gakkai Zasshi*

J. Jap. Tech. Ass. Pulp Pap. Ind.
Journal of the Japanese Technical Association of Pulp and Paper Industry
see Kami Pa Gikyoshi

J. Jap. Wood Res. Soc.
Journal of the Japan Wood Research Society
see *Mokuzai Gakkaishi*

J. Macromol. Sci., Part A
Journal of Macromolecular Science, Part A. Chemistry (supersedes Journal of Macromolecular Chemistry) *(U. S.)*

J. Nagasaki Med. Ass., Suppl.
Journal of the Nagasaki Medical Association, Supplement
see *Nagasaki Igakkai Zasshi, Suppl.*

J. Nucl. Sci. (Seoul)
*Journal of Nuclear Sciences (Seoul) (Wonjaryogwon. Yon'gu Nonmun Chip) *(South Korea)*

J. Phys., A (London)
*Journal of Physics, A (London), Proceedings of the Physical Society (General) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., B (London)
*Journal of Physics, B (London), Proceedings of the Physical Society (Atomic and Molecular Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., C (London)
*Journal of Physics, C (London), Proceedings of the Physical Society (Solid State Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., E (London)
*Journal of Physics, E (London) (supersedes Journal of Scientific Instruments) *(England)*

J. Phys. Chem. Solids, Suppl.
*Journal of Physics and Chemistry of Solids, Supplement *(England)*
J. Radiol. Phys. Ther., Univ. Kanazawa
Journal of Radiology and Physical Therapy, University of Kanazawa, The
see Kanazawa Irigaku Sosho
J. Soc. Eng. Miner. Springs, Jap.
Journal of the Society of Engineers for Mineral Springs, Japan
see Onsen Kogakkaishi
J. Soc. Fiber Sci. Technol., Jap.
Journal of the Society of Fiber Science and Technology, Japan
see Sen'i Gakkaishi
J. Soc. Instr. Contr. Eng.
Journal of the Society of Instrument and Control Engineers
see Keisoku To Seigyo
J. Soc. Rubber Ind., Jap.
Journal of the Society of Rubber Industry, Japan
see Nippon Gomu Kyokaishi
Kagaku Keisatsu Kenkyusho Hokoku
Kagaku Keisatsu Kenkyusho Hokoku (Reports of the National Research Inst. of Police Science) *(Japan)*
Kagoshima Daigaku Suisangakubu Kiyo
Kagoshima Daigaku Suisangakubu Kiyo (Memoirs of the Faculty of Fisheries, Kagoshima University) *(Japan)*
Kaibogaku Zasshi
Kaibogaku Zasshi (Acta Anatomica Nipponica) *(Japan)*
Kami Pa Gikyoshi
Kami Pa Gikyoshi (Journal of the Japanese Technical Association of Pulp and Paper Industry) *(Japan)*
Kanazawa Irigaku Sosho
Kanazawa Irigaku Sosho (Journal of Radiology and Physical Therapy, University of Kanazawa, The) *(Japan)*
Keisoku To Seigyo
Keisoku To Seigyo (Journal of the Society of Instrument and Control Engineers) *(Japan)*
Klin. Monatsbl. Augenheilk.
Klinische Monatsblaetter fuer Augenheilkunde und fuer Augenaerztliche Fortbildung *(West Germany)*
Koatsu Gasu
Koatsu Gasu (Journal of the Inst. of Safety of High Pressure Gas Engineering) *(Japan)*
Kobe Kogyo Giho
Kobe Kogyo Giho (Kobe Kogyo Technical Report) *(Japan)*
Kobe Kogyo Tech. Rep.
Kobe Kogyo Technical Report
see Kobe Kogyo Giho
K'o Hsueh Ta Chung
K'o Hsueh Ta Chung (Popular Science) *(China)*
Kokubyo Gakkai Zasshi
Kokubyo Gakkai Zasshi (Journal of the Japan Stomatological Society, The) *(Japan)*
Konkurito Janaru
Konkurito Janaru (Concrete Journal) *(Japan)*
Konserv. Ovoshchesush. Prom.
Konservnaya i Ovoshchesushil'naya Promyshlennost *(U.S.S.R.)*
Korroz. Metal. Splavov
Korroziya Metallov i Splavo *(U.S.S.R.)*
Kosm. Biol. Med.
Kosmicheskaya Biologiya i Meditsina *(U.S.S.R.)*
Kosm. Luchi
Kosmicheskie Luchi *(U.S.S.R.)*
Kovove Mater.
Kovove Materialy *(Czechoslovakia)*
Kumamoto Daigaku Kogakubu Kenkyu Hokoku
Kumamoto Daigaku Kogakubu Kenkyu Hokoku (Technical Reports of the Kumamoto University) *(Japan)*
Kumamoto Daigaku Kyoikugakubu Kiyo
Kumamoto Daigaku Kyoikugakubu Kiyo (Memoirs of the Faculty of Education, Kumamoto University) *(Japan)*
Kurznachr. Akad. Wiss. Goettingen
Kurznachrichten der Akademie der Wissenschaften in Goettingen *(West Germany)*
Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku
Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku (Report of the Training Inst. for Engineering Teachers, Kyoto University) *(Japan)*
Kyushu Daigaku Kogaku Shuho
Kyushu Daigaku Kogaku Shuho (Technology Reports of the Kyushu University) *(Japan)*
Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku
Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku (The Reports of the Research Inst. of Science and Industry, Kyushu University) *(Japan)*
Landbouwtijdschrift
Landbouwtijdschrift *(Belgium)*
Lasers Opt. Non Conv.
Lasers et Optique Non Conventionelle *(France)*
Lebensversicherungsmedizin
Lebensversicherungsmedizin *(West Germany)*
Lipids
Lipids *(U. S.)*
Liteinoe Proizvod.
Liteinoe Proizvodstvo *(U.S.S.R.)*
Machinery (N. Y.)
Machinery (New York) *(U. S.)*
Mach. Prod. Eng.
Machinery and Production Engineering *(England)*
Mach. Shop Eng. Mfg.
Machine Shop and Engineering Manufacture *(England)*
Mach. Tool Blue Book
Machine and Tool Blue Book *(U. S.)*
Mag. Stand.
Magazine of Standards *(U. S.)*
Magy. Traumatol., Orthop. Helyreallito Sebesz.
Magyar Traumatologia, Orthopaedia es Helyreallito Sebeszet *(Hungary)*
Mashinovedenie
Mashinovedenie *(U.S.S.R.)*
Mass Prod.
Mass Production *(England)*
Mater. Res. Bull.
Materials Research Bulletin *(U. S.)*
Mem. Fac. Educ., Kumamoto Univ.
Memoirs of the Faculty of Education, Kumamoto University
see Kumamoto Daigaku Kyoikugakubu Kiyo
Mem. Fac. Fish., Kagoshima Univ.
Memoirs of the Faculty of Fisheries, Kagoshima University
see Kagoshima Daigaku Suisangakubu Kiyo
Mem. Fac. Sci., Kyoto Univ., Ser. Biol.
Memoirs of the Faculty of Science, Kyoto University, Series of Biology (formerly Memoirs of the College of Science, University of Kyoto, Series B (Biology)) *(Japar*
Mem. Fac. Sci., Kyoto Univ., Ser. Phys., Astrophys., phys., Chem.
Memoirs of the Faculty of Science, Kyoto University, Series of Physics, Astrophysics, Geophysics, and Chemistry (formerly Memoirs of the College of Science, University of Kyoto, Series A) *(Japan)*
Mem. Hyogo Univ. Agr.
Memoirs of the Hyogo University of Agriculture
see Hyogo Noka Daigaku Kiyo
Meres Automat.
Meres es Automatika *(Hungary)*
Mes., Regul., Automat.
Mesures, Regulation, Automatisme *(France)*
Metabolism
*Metabolism: Clinical and Experimental *(U. S.)*
Metallwirtschaft
Metallwirtschaft–Wissenschaft–Technik *(Germany)*
Metals (London)
Metals (London) *(England)*
Metals Abstr.
*Metals Abstracts (successor to Review of Metal Literature and Metallurgical Abstracts) *(U. S.-England)*
Metal Sci. Heat Treat. (USSR) (Engl. Transl.)
Metal Science and Heat Treatment (USSR) (English Translation of Metallovedenie i Termicheskaya Obrabotka Metallov) *(U. S.)*
Metal Treat.
Metal Treating *(U. S.)*
Met. Elec. (Madrid)
Metalurgia y Electricidad (Madrid) *(Spain)*
Met. Rev. (Publ. in Metals Mater.)
Metallurgical Reviews (Published in Metals and Materials) *(England)*
Microwaves
Microwaves *(U. S.)*
Mod. Packag.
Modern Packaging *(U. S.)*
Mokuzai Gakkaishi
Mokuzai Gakkaishi (Journal of the Japan Wood Research Society) *(Japan)*
Mol. Biol.
*Molekulyarnaya Biologiya *(U.S.S.R.)*
Monit. Zool. Ital., Suppl.
Monitore Zoologico Italiano, Supplemento *(Italy)*
Montes
Montes *(Spain)*
Motortech. Z.
Motortechnische Zeitschrift *(West Germany)*

Nachrichtentechnik
Nachrichtentechnik *(East Germany)*
Nagasaki Igakkai Zasshi, Suppl.
Nagasaki Igakkai Zasshi, Supplement (Journal of the Nagasaki Medical Association, Supplement) *(Japan)*
Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Universitatis Nankinensis Scientiarum Naturalium) *(China)*
Nat. Fire Codes
National Fire Codes *(U. S.)*
Nat. Med. J. China
National Medical Journal of China
see Chung Hua I Hsueh Tsa Chih
Nauch. Zap. Inst. Mashinoved. Avtomat., Akad. Nauk Ukr. SSR, Ser. Mashinoved.
Nauchnye Zapiski Instituta Mashinovedeniya i Avtomatiki, Akademiya Nauk Ukraninskoi SSR, Seriya Mashinovedeniya *(Ukrainian S.S.R.)*
Neth. J. Sea Res.
Netherlands Journal of Sea Research *(Netherlands)*
Neues Jahrb. Mineral., Monatsh.
Neues Jahrbuch fuer Mineralogie, Monatshefte *(West Germany)*
Nippon Byori Gakkai Kaishi
Nippon Byori Gakkai Kaishi (Transactiones Societatis Pathologicae Japonicae) *(Japan)*
Nippon Chikusangaku Kaiho
Nippon Chikusangaku Kaiho (Japanese Journal of Zootechnical Science) *(Japan)*
Nippon Geka Hokan
Nippon Geka Hokan (Archiv fuer Japanische Chirurgie) *(Japan)*
Nippon Gomu Kyokaishi
Nippon Gomu Kyokaishi (Journal of the Society of Rubber Industry, Japan) *(Japan)*
Nippon Sakumotsu Gakkai Kiji
Nippon Sakumotsu Gakkai Kiji (Proceedings of the Crop Science Society of Japan) *(Japan)*
Nisshin Seiko Giho
Nisshin Seiko Giho (Technical Report of Nisshin Steel Co., Ltd.) *(Japan)*
Norsk Skogind.
Norsk Skogindustri *(Norway)*
Nukleonika, Supl.
*Nukleonika, Suplement *(Poland)*
N. Z. Sci. Rev.
New Zealand Science Review *(New Zealand)*
Oceanogr. Mag.
Oceanographical Magazine, The *(Japan)*
Ochr. Pr.
Ochrona Pracy *(Poland)*
Okayama Daigaku Onsen Kenkyusho Hokoku
Okayama Daigaku Onsen Kenkyusho Hokoku (Papers of the Inst. for Thermal Spring Research, Okayama University) *(Japan)*
Onde Elec., Suppl.
*Onde Electrique, L, Supplement *(France)*
Onsen Kagaku
Onsen Kagaku (Journal of the Balneological Society of Japan) *(Japan)*
Onsen Kogakkaishi
Onsen Kogakkaishi (Journal of the Society of Engineers for Mineral Springs, Japan) *(Japan)*
Opt.-Mekh. Prom.
Optiko-Mekhanicheskaya Promyshlennost *(U.S.S.R.)*
Osaka Furitsu Kogyo Shoreikan Hokoku
Osaka Furitsu Kogyo Shoreikan Hokoku (Reports of Industrial Research Inst., Osaka Prefecture) *(Japan)*
Oto-Rhino-Laryngol. Clin.
Oto-Rhino-Laryngological Clinic
see Jibiinkoka Rinsho
Paperi Puu-Lehdesta
Paperi ja Puu-Lehdesta *(Finland)*
Pap. Inst. Thermal Spring Res., Okayama Univ.
Papers of the Inst. for Thermal Spring Research, Okayama University
see Okayama Daigaku Onsen Kenkyusho Hokoku
Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Scientiarum Naturalium Universitatis Pekinensis) *(China)*
Photogr. Appl. Sci. Technol.
*Photographic Applications in Science and Technology *(U. S.)*
Phys.-Diaet. Ther.
Physikalisch-Diaetetische Therapie *(West Germany)*
Phys. Earth Planet. Interiors
*Physics of the Earth and Planetary Interiors *(Netherlands)*
Piping Eng.
Piping Engineering, The
see Haikan Gijutsu
Plant Breed. Abstr.
*Plant Breeding Abstracts *(England)*
Plant Cell Physiol. (Kyoto)
Plant and Cell Physiology (Kyoto) *(Japan)*
Poluprov. Prib. Ikh Primen., Sb. Statei
Poluprovodnikovye Pribory i Ikh Primenenie, Sbornik Statei *(U.S.S.R.)*
Pop. Sci. (Peking)
Popular Science (Peking)
see K'o Hsueh Ta Chung
Poznan. Tow. Przyj. Nauk, Wydz. Lek., Pr. Kom. Farm.
Poznanskie Towarzystwo Przyjaciol Nauk, Wydzial Lekarski, Prace Komisji Farmaceutycznej *(Poland)*
Praxis (Bern)
Praxis (Bern) *(Switzerland)*
Probl. Fiziol. Opt.
Problemy Fiziologicheskoi Optiki *(U.S.S.R.)*
Proc. Amer. Soc. Hort. Sci.
Proceedings of the American Society for Horticultural Science *(U. S.)*
Proc. Astron. Soc. Aust.
Proceedings of the Astronomical Society of Australia *(Australia)*
Proc. Crop Sci. Soc. Jap.
Proceedings of the Crop Science Society of Japan
see Nippon Sakumotsu Gakkai Kiji
Proc. Indian Acad. Sci., Sect. B
Proceedings of the Indian Academy of Sciences, Section B *(India)*
Proc. La. Acad. Sci.
*Proceedings of the Louisiana Academy of Sciences, The *(U. S.)*
Proc. Nat. Acad. Sci., India, Sect. A
Proceedings of the National Academy of Sciences, India, Section A *(India)*
Proc. Phys. Soc. (London)
Proceedings of the Physical Society (London) changed to Journal of Physics, A, B, and C *(England)*
Proc. Soc. Water Treat. Exam.
Proceedings of the Society for Water Treatment and Examination *(England)*
Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.)
*Proceedings (Trudy) of the P. N. Lebedev Physics Institute (USSR) (English Translation of Trudy Fizicheskogo Instituta imeni P. N. Lebedeva, Akademiya Nauk SSSR) *(U. S.)*
Progr. Ind. Microbiol.
Progress in Industrial Microbiology *(U. S.–England)*
Progr. Solid State Chem.
Progress in Solid State Chemistry *(England)*
Prot. Civ. Secur. Ind.
Protection Civile et Securite Industrielle *(France)*
Queensland Govt. Mining J.
Queensland Government Mining Journal *(Australia)*
Radio (China)
Radio (China)
see Wu Hsien Tien
Radiobiol. Biol. Mol.
Radiobiologia si Biologia Moleculara *(Romania)*
Radioprotection
Radioprotection. Bulletin de la Societe Francaise de Radioprotection *(France)*
Rad. Poljopr. Fak. Univ. Sarajevu
Radovi Poljoprivrednog Fakulteta Univerziteta u Sarajevu *(Yugoslavia)*
Rakuno Kagaku No Kenkyu
Rakuno Kagaku No Kenkyu (Japanese Journal of Dairy Science) *(Japan)*
Reactor Fuel-Process. Technol.
*Reactor and Fuel-Processing Technology (A Quarterly Technical Progress Review) (formerly Power Reactor Technology and Reactor Fuel Processing) *(U. S.)*
Rec. Trav. Bot. Neer.
Recueil des Travaux Botaniques Neerlandais *(Netherlands)*
Rep. Fac. Sci., Shizuoka Univ.
Reports of Faculty of Science, Shizuoka University *(Japan)*
Rep. Fire Res. Inst. Jap.
Report of Fire Research Inst. of Japan
see Shobo Kenkyusho Hokoku
Rep. Ind. Res. Inst., Osaka Prefect.
Reports of Industrial Research Inst., Osaka Prefecture
see Osaka Furitsu Kogyo Shoreikan Hokoku
Rep. Nat. Res. Inst. Police Sci.
Reports of the National Research Inst. of Police Science
see Kagaku Keisatsu Kenkyusho Hokoku
Rep. Res. Inst. Ind. Safety

Reports of the Research Inst. of Industrial Safety
see Sangyo Anzen Kenkyusho Hokoku
Rep. Res. Inst. Sci. Ind., Kyushu Univ.
Reports of the Research Inst. of Science and Industry, Kyushu University
see Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku
Rep. Tokyo-to Lab. Med. Sci.
Report of Tokyo-to Lab. for Medical Sciences
see Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku
Rep. Train. Inst. Eng. Teach., Kyoto Univ.
Report of the Training Inst. for Engineering Teachers, Kyoto University
see Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku
Res. Electrotech. Lab.
Researches of the Electrotechnical Laboratory
see Denki Shikenjo Kenkyu Hokoku
Rev. Acad. Cienc. Exactas, Fis.-Quim. Natur. Zaragoza
Revista de la Academia de Ciencias Exactas, Fisico-Quimicas y Naturales de Zaragoza *(Spain)*
Rev. Brasil. Quim. (Sao Paulo)
*Revista Brasileria de Quimica *(Brazil)*
Rev. Elec.
Revista Electricidade *(Portugal)*
Rev. Fr. Elec.
*Revue Francaise de l' Electricite *(France)*
Rev. Interamer. Radiol.
Revista Interamericana de Radiologia *(Peru)*
Rev. Roum. Sci. Tech., Ser. Mecan. Appl.
Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee *(Romania)*
Rev. Zooteh. Med. Vet.
Revista de Zootehnic si Medicina Veterinara *(Romania)*
Roy. Observ. Bull.
Royal Observatory Bulletins *(England)*
Roy. Soc. Health J.
Royal Society of Health Journal *(England)*
Ruimtevaart
Ruimtevaart *(Netherlands)*
RUM, Rev. Universelle Mines
RUM, Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l' Industrie (formerly Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l'Industrie) *(Belgium)*
S. Afr. Mech. Eng.
South African Mechanical Engineer, The *(South Africa)*
Samoletostr. Tekh. Vozdush. Flota
Samoletostroenie i Tekhnika Vozdushnogo Flota *(U.S.S.R.)*
Sangyo Anzen Kenkyusho Hokoku
Sangyo Anzen Kenkyusho Hokoku (Reports of the Research Inst. of Industrial Safety) *(Japan)*
Sb. Geol. Ved, Uzita Geofyz.
Sbornik Geologickych Ved, Uzita Geofyzika *(Czechoslovakia)*
Sb. Ved. Pr. Lek. Fak. Karlovy Univ. Hradci Kralove, Suppl.
Sbornik Vedeckych Praci Lekarske Fakulty Karlovy University v Hradci Kralove, Supplementum *(Czechoslovakia)*
Scand. J. Clin. Lab. Invest., Suppl.
Scandinavian Journal of Clinical and Laboratory Investigation, Supplement *(Sweden)*
Sci. Ind. Spatiales
Sciences et Industries Spatiales *(Switzerland)*
Sci. News (Wash., D. C.)
Science News (Washington, D. C.) *(U. S.)*
Sci. Proc. Roy. Dublin Soc., Ser. A
Scientific Proceedings of the Royal Dublin Society, The, Series A (supersedes The Scientific Proceedings of the Royal Dublin Society, New Series) *(Ireland)*
Sci. Rep., Coll. Gen. Educ., Osaka Univ.
Science Report, College of General Education, Osaka University *(Japan)*
Sci. Rep. Niigata Univ., Ser. B
Science Reports of Niigata University, Series B. Physics *(Japan)*
Scr. Met.
Scripta Metallurgica *(U. S.)*
Seminars Hematol.
*Seminars in Hematology *(U. S.)*
Seminars Roentgenol.
Seminars in Roentgenology *(U. S.)*
Sen'i Gakkaishi
Sen'i Gakkaishi (Journal of the Society of Fiber Science and Technology, Japan) *(Japan)*
Ser. Haematol.
Series Haematologica (Supplements Scandinavia Journal of Haematology) *(Denmark)*
Sheet Metal Ind.
Sheet Metal Industries *(England)*
Shipping World Shipbuilder
Shipping World and Shipbuilder *(England)*
Shobo Kenkyusho Hokoku
Shobo Kenkyusho Hokoku (Report of Fire Research Inst. of Japan) *(Japan)*
Showa Densen Denran Rebyu
Showa Densen Denran Rebyu (Showa Wire and Cable Review) *(Japan)*
Showa Wire Cable Rev.
Showa Wire and Cable Review
see Showa Densen Denran Rebyu
Sichere Arb.
Sichere Arbeit *(Austria)*
Slaboproudy Obz.
Slaboproudy Obzor *(Czechoslovakia)*
Soc. Petrol. Eng. J.
Society of Petroleum Engineers Journal, The *(U. S.)*
Soil Crop Sci. Soc. Fla., Proc.
Soil and Crop Science Society of Florida, Proceedings *(U. S.)*
Soobshch. Shemakhinskoi Astrofiz. Observ., Akad. Nauk Azerb. SSR
*Soobshcheniya Shemakhinskoi Astrofizicheskoi Observatorii, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*
Sov. Antarct. Exped. Inform. Bull.
Soviet Antarctic Expedition Information Bulletin (English Translation of Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii) *(U. S.)*
Sov. Phys.-Semicond. (Engl. Transl.)
Soviet Physics-Semiconductors (English Translation of Fizika i Tekhnika Poluprovodnikov) *(U. S.)*
Steel Times
Steel Times *(England)*
Strain
Strain *(England)*
Stud. Cercet. Endocrinol.
Studii si Cercetari de Endocrinologie *(Romania)*
Stud. Cercet. Energ. Electroteh.
Studii si Cercetari de Energetica si Electrotehnica *(Romania)*
Svetsaren Engl.
Svetsaren in English *(Sweden)*
Tech. Dig. (Prague)
Technical Digest (Prague), Statni Nakladetelstvi Technicke Literatury *(Czechoslovakia)*
Technik (Berlin)
Technik (Berlin), Die *(East Germany)*
Technol. Rep. Kyushu Univ.
Technology Reports of the Kyushu University
see Kyushu Daigaku Kogaku Shuho
Tech. Rep. ISSP (Inst. Solid State Phys.), Ser. A
Technical Report of ISSP (Inst. for Solid State Physics), Series A *(Japan)*
Tech. Rep. Kumamoto Univ.
Technical Reports of the Kumamoto University
see Kumamoto Daigaku Kogakubu Kenkyu Hokoku
Tech. Rep. Nisshin Steel Co., Ltd.
Technical Report of Nisshin Steel Co., Ltd.
see Nisshin Seiko Giho
Tekhnol. Organ. Proizvod.
Tekhnologiya i Organizatsiya Proizvodstva *(Ukrainian S.S.R.)*
Teor. Prakt. Met., Sov. Nar. Khoz. Chelyabinsk. Ekon. Admin. Raiona, Nauch.-Issled. Inst. Met.
Teoriya i Praktika Metallurgii, Sovet Narodnogo Khozyaistva Chelyabinskogo Ekonomicheskogo Administrativnogo Raiona, Nauchno-Issledovatel'skii Institut Metallurgii *(U.S.S.R.)*
Terapia (Milan)
Terapia (Milan) *(Italy)*
Terapia (Turin)
Terapia (Turin) *(Italy)*
Tien Shih Chieh
Tien Shih Chieh (Electrical World) *(China)*
Tohoku Daigaku Senko Seiren Kenkyusho Iho
Tohoku Daigaku Senko Seiren Kenkyusho Iho (Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University) *(Japan)*
Tokyo Daigaku Uchu Koku Kenkyusho Hokoku
Tokyo Daigaku Uchu Kenkyusho Hokoku (Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo) *(Japan)*
Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku
Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku (Report of Tokyo-to Lab. for Medical Sciences) *(Japan)*
Tonind.-Ztg. Keram. Rundsch.
Tonindustrie-Zeitung und Keramische Rundschau *(West Germany)*

Trans. Amer. Ophthalmol. Soc.
Transactions of the American Ophthalmological Society *(Canada)*
Trans. Indian Ceram. Soc.
Tranactions of the Indian Ceramic Society *(India)*
Transp. Stroit.
Transportnoe Stroitel'stvo *(U.S.S.R.)*
Trans. Soc. Instrum. Contr. Eng.
Transactions of the Society of Instrument and Control Engineers *(Japan)*
Trans. Soc. Pathol. Jap.
Transactiones Societatis Pathologicae Japonicae
see Nippon Byori Gakkai Kaishi
Tr. Gos. Issled. Elektrokeram. Inst.
Trudy Gosudarstvennogo Issledovatel'skogo Elektrokeramicheskogo Instituta *(U.S.S.R.)*
Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial
Trudy Instituta Biologii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*
Tr., Mosk. Aviats. Tekhnol. Inst.
Trudy, Moskovskii Aviatsionnyi Tekhnologicheskii Institut *(U.S.S.R.)*
Tr. Mosk. Vet. Akad.
Trudy Moskovskoi Veterinarnoi Akademii *(U.S.S.R.)*
TRW Space Log
TRW Space Log *(U. S.)*
Tumor Res.
Tumor Research *(Japan)*
T Z Prakt. Metallbearb.
T Z fuer Praktische Metallbearbeitung *(West Germany)*
Vector (Baltimore)
Vector (Baltimore) *(U. S.)*
Ved. Pr. Vyzk. Ustavu Vet. Lek. Brne
Vedecke Prace Vyzkumneho Ustavu Veterinarniho Lekarstvi v Brne (superseded by Documenta Veterinaria) *(Czechoslovakia)*
Vestn. Cesk. Spolecnosti Zool.
Vestnik Ceskoslovenske Spolecnosti Zoologicke *(Czechoslovakia)*
Vestn. Mosk. Univ., Ser. IV. Geol.
Vestnik Moskovskogo Universiteta, Seriya IV. Geologiya *(U.S.S.R.)*
Vodosnabzh. Sanit. Tekh.
Vodosnabzhenie i Sanitarnaya Tekhnika *(U.S.S.R.)*
Vojnosanit. Pregl.
Vojnosanitetski Pregled *(Yugoslavia)*
Volt, Elec. Trade Mon.
Volt, Electrical Trade Monthly *(Japan)*
Vop. Eksp. Klin. Radiol., Khar'kov. Inst. Med. Radiol.
Voprosy Eksperimental'noi i Klinicheskoi Radiologii, Khar'kovskii Institut Meditsinskoi Radiologii *(Ukrainian S.S.R.)*
Water Res.
Water Research (supersedes in part Air and Water Pollution) *(England)*
Water Waste Treat.
Water and Waste Treatment *(England)*
Weld. Res. Counc. Bull.
Welding Research Council Bulletin *(U. S.)*
Wien. Z. Inn. Med. Grenzgeb.
Wiener Zeitschrift fuer Innere Medizin und ihre Grenzgebiete *(Austria)*
Wiss. Z. Ernst-Moritz-Arndt-Univ. Greifswald, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrfit der Ernst-Moritz-Arndt-Universitaet Greifswald, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*
Wonjaryegwon. Yon'gu Nonmun Chip
Wonjaryogwon. Yon'gu Nonmun Chip
see J. Nucl. Sci. (Seoul)
Wu Hsien Tien
Wu Hsien Tien (Radio) *(China)*
Yadern. Priborostr., Nauch.-Tekh. Sb.
Yadernoe Priborostroenie, Nauchno-Tekhnicheskii Sbornik *(U.S.S.R.)*
Yakugaku Kenkyu
Yakugaku Kenkyu (Japanese Journal of Pharmacy and Chemistry) *(Japan)*
Yuan Tzu Neng
Yuan Tzu Neng (Atomic Energy) *(China)*
Zap. Leningrad. Gorn. Inst.
Zapiski Leningradskogo Gornogo Instituta *(U.S.S.R.)*
Zem. Beton
Zement und Beton *(Austria)*
Z. Math. Phys.
Zeitschrift fuer Mathematik und Physik *(East Germany)*
Z. Mikrosk.-Anat. Forsch.
Zeitschrift fuer Mikroskopisch-Anatomische Forschung (Abt. 2 of Jahrbuch fuer Morphologie und Mikroskopische Anatomie) *(East Germany)*
Zool. Zh.
Zoologicheskii Zhurnal *(U.S.S.R.)*
Z. Phys. Chem. B
Zeitschrift fuer Physikalische Chemie. Abt. B *(Germany)*
Z. Tech. Ueberwach.
Zeitschrift Technische Ueberwachung *(Austria)*

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